RF TEST REPORT

ISSUED BY
Shenzhen BALUN Technology Co., Ltd.

FOR

Notebook Computer

ISSUED TO
Lenovo (Shanghai) Electronics Technology Co., Ltd.

Section 304-305, Building No. 4, # 222, Meiyue Road, China (Shanghai) Pilot Free Trade Zone, 200131, CHINA

Report No.:	BL-SZ21C0792-601
EUT Name:	Notebook Computer
Model Name:	IP Duet 3 Chrome 11Q727 (refer section 2.3)
Brand Name:	Lenovo
Test Standard:	47 CFR Part 15 Subpart C RSS-Gen Issue 5 RSS-247 Issue 2 (refer section 3.1)
FCC ID:	O57DUET3CB7C
ISED Number:	10407A-DUET3CB7C
Test Conclusion:	Pass
Test Date:	Jan. 08, 2022 ~ Jan. 12, 2022
Date of Issue:	Feb. 17, 2022

Tested by: Yu Yingyuan
Date: Feb. 17, 2022

Approved by: Liao Jianming
(Technical Director)
Date: Feb. 17, 2022

NOTE: This test report of test results only related to testing samples, which can be duplicated completely for the legal use with the approval of the applicant; it shall not be reproduced except in full, without the written approval of Shenzhen BALUN Technology Co., Ltd. Any objections should be raised within thirty days from the date of issue. To validate the report, please contact us.

Block B, 1st FL, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong, P. R. China 518055
TEL: +86-755-66850100, FAX: +86-755-61824271
Email: qc@baluntek.com
www.baluntek.com

Revision History

Version	Issue Date	Revisions Content
Rev. 01	Feb. 17, 2022	Initial Issue

TABLE OF CONTENTS

1 ADMINISTRATIVE DATA (GENERAL INFORMATION) 5
1.1 Identification of the Testing Laboratory 5
1.2 Identification of the Responsible Testing Location 5
1.3 Laboratory Condition 5
1.4 Announce 5
2 PRODUCT INFORMATION 6
2.1 Applicant Information 6
2.2 Manufacturer Information 6
2.3 General Description for Equipment under Test (EUT) 6
2.4 Technical Information 7
2.5 Additional Instructions 9
3 SUMMARY OF TEST RESULTS 10
3.1 Test Standards 10
3.2 Verdict 11
4 GENERAL TEST CONFIGURATIONS 12
4.1 Test Environments 12
4.2 Test Equipment List 12
4.3 Test Software List 12
4.4 Measurement Uncertainty 13
4.5 Description of Test Setup 13
4.5.1 For Antenna Port Test 13
4.5.2 For AC Power Supply Port Test 14
4.5.3 For Radiated Test (Below 30 MHz) 14
4.5.4 For Radiated Test (30 MHz-1 GHz) 15
4.5.5 For Radiated Test (Above 1 GHz) 15
4.6 Measurement Results Explanation Example 16
4.6.1 For conducted test items: 16

5 TEST ITEMS 17
5.1 Antenna Requirements 17
5.1.1 Relevant Standards 17
5.1.2 Antenna Anti-Replacement Construction 17
5.1.3 Antenna Gain 17
5.2 Frequency Hopping Systems 18
5.2.1 Relevant Standards 18
5.2.2 Description of the systems 18
5.3 Number of Hopping Frequencies 20
5.3.1 Limit 20
5.3.2 Test Setup 20
5.3.3 Test Procedure 20
5.3.4 Test Result 20
5.4 Peak Output Power and E.I.R.P 21
5.4.1 Test Limit 21
5.4.2 Test Setup 21
5.4.3 Test Procedure 21
5.4.4 Test Result 21
5.5 Occupied Bandwidth 22
5.5.1 Limit 22
5.5.2 Test Setup 22
5.5.3 Test Procedure 22
5.5.4 Test Result 22
5.6 Carrier Frequency Separation 23
5.6.1 Limit 23
5.6.2 Test Setup 23
5.6.3 Test Procedure 23
5.6.4 Test Result 23
5.7 Time of Occupancy (Dwell time) 24
5.7.1 Limit 24
5.7.2 Test Setup 24
5.7.3 Test Procedure 24

5.7.4 Test Result 25
5.8 Conducted Spurious Emission & Authorized-band band-edge 26
5.8.1 Limit 26
5.8.2 Test Setup 26
5.8.3 Test Procedure 26
5.8.4 Test Result 26
5.9 Conducted Emission 27
5.9.1 Limit 27
5.9.2 Test Setup 27
5.9.3 Test Procedure 27
5.9.4 Test Result 27
5.10 Radiated Spurious Emission 28
5.10.1 Limit 28
5.10.2 Test Setup 28
5.10.3 Test Procedure 28
5.10.4 Test Result 29
5.11 Band Edge (Restricted-band band-edge) 30
5.11.1 Limit 30
5.11.2 Test Setup 30
5.11.3 Test Procedure 30
5.11.4 Test Result 30
ANNEX A TEST RESULT 31
A.1 Number of Hopping Frequency 31
A.2 Peak Output Power and E.I.R.P 32
A.3 20 dB and 99% bandwidth 35
A.4 Hopping Frequency Separation 40
A.5 Average Time of Occupancy 41
A.6 Conducted Spurious Emissions & Authorized-band band-edge 44
A.7 Conducted Emissions 51
A.8 Radiated Spurious Emission 53
A.9 Band Edge (Restricted-band band-edge) 67
ANNEX B TEST SETUP PHOTOS 71

1 ADMINISTRATIVE DATA (GENERAL INFORMATION)

1.1 Identification of the Testing Laboratory

Company Name	Shenzhen BALUN Technology Co., Ltd.
Address	Block B, 1st FL, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Phone Number	+86 755 6685 0100

1.2 Identification of the Responsible Testing Location

Test Location	Shenzhen BALUN Technology Co., Ltd.
Address	Block B, 1st FL, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Accreditation Certificate	The laboratory has been listed by Industry Canada to perform electromagnetic emission measurements. The recognition numbers of test site are 11524A-1. The laboratory is a testing organization accredited by FCC as a accredited testing laboratory. The designation number is CN1196.
Description	All measurement facilities used to collect the measurement data are located at Block B, FL 1, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China 518055

1.3 Laboratory Condition

Ambient Temperature	20℃ to 25℃
Ambient Relative Humidity	45% to 55%
Ambient Pressure	100 kPa to 102 kPa

1.4 Announce

(1) The test report reference to the report template version v5.7.

(2) The test report is invalid if not marked with the signatures of the persons responsible for preparing and approving the test report.

(3) The test report is invalid if there is any evidence and/or falsification.

(4) The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein.

(5) This document may not be altered or revised in any way unless done so by BALUN and all revisions are duly noted in the revisions section.

(6) Content of the test report, in part or in full, cannot be used for publicity and/or promotional purposes without prior written approval from the laboratory.

(7) The laboratory is only responsible for the data released by the laboratory, except for the part provided by the applicant.

2 PRODUCT INFORMATION

2.1 Applicant Information

Applicant	Lenovo (Shanghai) Electronics Technology Co., Ltd.
Address	Section 304-305, Building No. 4, # 222, Meiyue Road, China (Shanghai) Pilot Free Trade Zone, 200131, CHINA

2.2 Manufacturer Information

Manufacturer	Lenovo PC HK Limited
Address	23/F, Lincoln House, Taikoo Place 979 King's Road, Quarry Bay, Hong Kong, P.R. China

2.3 General Description for Equipment under Test (EUT)

EUT Name	Notebook Computer
Model Name Under Test	IP Duet 3 Chrome 11Q727
Series Model Name	IP Duet 3 Chrome 11******* (* can be 0-9, a-z, A-Z, any symbol, blank or nothing)
Description of Model name differentiation	Only differences are model names for trading purpose.
Serial Number	YX03EWG5
Hardware Version	V5
Software Version	R97-14324.31.0 (dev channel)
Dimensions (Approx.)	N/A
Weight (Approx.)	N/A

Antenna Information:

Antenna Port	Model Name	Antenna Manufacturer	Antenna Type	Antenna Gain (dBi)			
				2.4 GHz	5.15-5.35 GHz	5.47-5.725 GHz	5.725-5.85 GHz
Main Antenna	2.00005205	ZhongTianXun	PIFA	1.92	2.77	2.71	2.39
Auxiliary Antenna	2.00005206		PIFA	**1.85**	2.71	2.89	2.54
Main Antenna	N12-8055-R0A	South Star	PIFA	1.55	2.05	2.23	0.52
Auxiliary Antenna	N12-8056-R0A		PIFA	1.18	2.05	1.93	1.46
Note: The report only shown the antenna which matches the antenna with the highest antenna gain.							

2.4 Technical Information

Network and Wireless connectivity	Bluetooth (BR+EDR+BLE) 2.4G WIFI 802.11b, 802.11g, 802.11n(HT20/40) 5G WIFI 802.11a, 802.11n(HT20/40), 802.11ac(VHT20/40/80) U-NII-1/2A/2C/3

The requirement for the following technical information of the EUT was tested in this report:

Modulation Technology	FHSS
Modulation Type	GFSK, π/4-DQPSK, 8-DPSK
Product Type	☐ Mobile ☒ Portable ☐ Fix Location
Transfer Rate	DH5: 1 Mbps 2DH5: 2 Mbps 3DH5: 3 Mbps
Frequency Range	The frequency range used is 2400 MHz to 2483.5 MHz.
Number of Channel	79 (at intervals of 1 MHz)
Tested Channel	0 (2402 MHz), 39 (2441 MHz), 78 (2480 MHz)
Antenna Type	PIFA Antenna
Antenna Gain	1.85 dBi (In test items related to antenna gain, the final results reflect this figure. This value is provided by the applicant.)
Antenna Impedance	50Ω
Antenna System (MIMO Smart Antenna)	N/A

All channel was listed on the following table:

Channel number	Freq. (MHz)	Channel number	Freq. (MHz)	Channel number	Freq. (MHz)	Channel number	Freq. (MHz)
0	**2402**	21	2423	42	2444	63	2465
1	2403	22	2424	43	2445	64	2466
2	2404	23	2425	44	2446	65	2467
3	2405	24	2426	45	2447	66	2468
4	2406	25	2427	46	2448	67	2469
5	2407	26	2428	47	2449	68	2470
6	2408	27	2429	48	2450	69	2471
7	2409	28	2430	49	2451	70	2472
8	2410	29	2431	50	2452	71	2473
9	2411	30	2432	51	2453	72	2474
10	2412	31	2433	52	2454	73	2475
11	2413	32	2434	53	2455	74	2476
12	2414	33	2435	54	2456	75	2477
13	2415	34	2436	55	2457	76	2478
14	2416	35	2437	56	2458	77	2479
15	2417	36	2438	57	2459	**78**	**2480**
16	2418	37	2439	58	2460	-	-
17	2419	38	2440	59	2461	-	-
18	2420	**39**	**2441**	60	2462	-	-
19	2421	40	2442	61	2463	-	-
20	2422	41	2443	62	2464	-	-

2.5 Additional Instructions

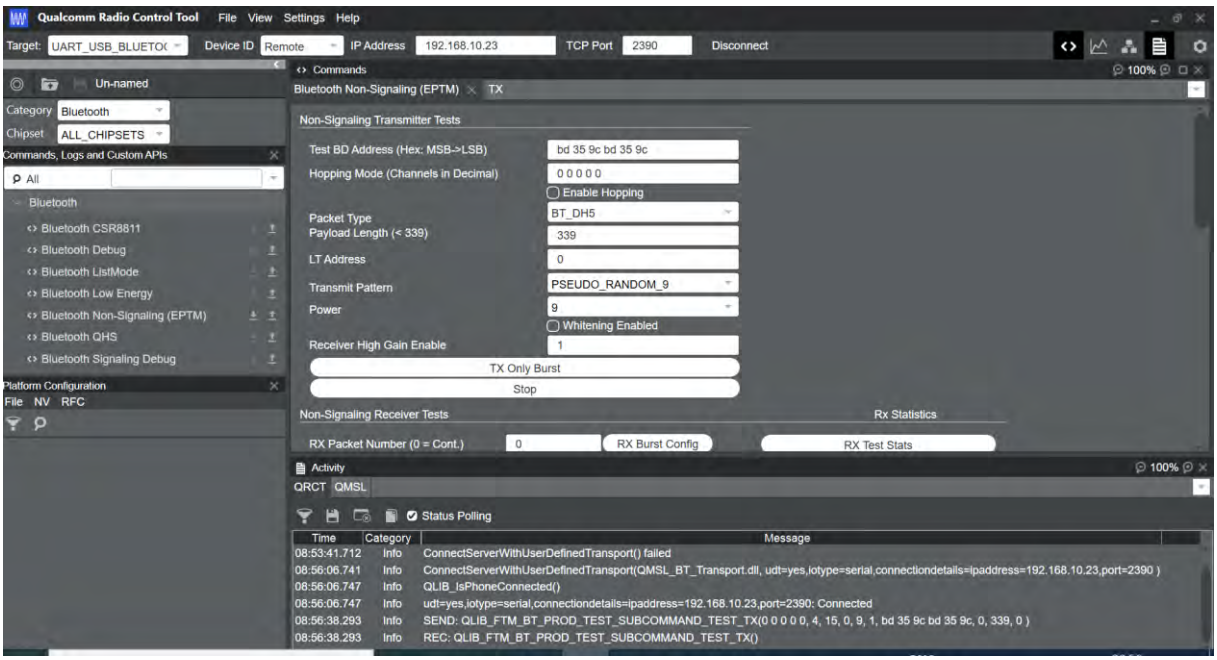
EUT Software Settings:

Mode	☒ Special software is used. The software provided by client to enable the EUT under transmission condition continuously at specific channel frequencies individually.

During testing, Channel and Power Controlling Software provided by the customer was used to control the operating channel as well as the output power level. The RF output power selection is for the setting of RF output power expected by the customer and is going to be fixed on the firmware of the final end product.

Power level setup in software			
Test Software Version	QRCT4		
Support Units (Software installation media)	Description	Manufacturer	Model
	Notebook	HP	N/A
Mode	Channel	Frequency (MHz)	Soft Set
DH5	CH0	2402	Power parameter Settings is 9
	CH39	2441	
	CH78	2480	
2DH5	CH0	2402	
	CH39	2441	
	CH78	2480	
3DH5	CH0	2402	
	CH39	2441	
	CH78	2480	

Run Software:



3 SUMMARY OF TEST RESULTS

3.1 Test Standards

No.	Identity	Document Title
1	47 CFR Part 15, Subpart C	Miscellaneous Wireless Communications Services
2	ANSI C63.10-2013	American National Standard for Testing Unlicensed Wireless Devices
3	KDB 558074 D01 15.247 Meas Guidance v05r02	Guidance for compliance measurements on digital transmission system, frequency hopping spread spectrum system, and hybrid system devices operating under section 15.247 of the FCC rules
4	RSS-Gen Issue 5	General Requirements for Compliance of Radio Apparatus
5	RSS-247 Issue 2	Digital Transmission Systems (DTSs), Frequency Hopping Systems(FHSs) and Licence-Exemp Local Area Network (LE-LAN) Devices

3.2 Verdict

No.	Description	FCC Part No.	ISED Part No.	Channel	Test Result	Verdict	Remark
1	Antenna Requirement	15.203	RSS-247, 5.4 (f)	N/A	--	Pass	Note [1]
2	Number of Hopping Frequencies	15.247(a)	RSS-247, 5.1 (d)	Hopping Mode	ANNEX A.1	Pass	Note [2]
3	Peak Output Power and E.I.R.P	15.247(b)	RSS-247, 5.4 (b)	Low/Middle/ High	ANNEX A.2	Pass	--
4	Occupied Bandwidth	15.247(a)	RSS-247, 5.1 (a)	Low/Middle/ High	ANNEX A.3	Pass	Note [2]
5	Carrier Frequency Separation	15.247(a)	RSS-247, 5.1 (b)	Hopping Mode	ANNEX A.4	Pass	Note [2]
6	Time of Occupancy (Dwell time)	15.247(a)	RSS-247, 5.1 (d)	Hopping Mode	ANNEX A.5	Pass	Note [2]
7	Conducted Spurious Emission & Authorized-band band-edge	15.247(d)	RSS-247, 5.5	Low/Middle/ High	ANNEX A.6	Pass	Note [2]
8	Conducted Emission	15.207	RSS-GEN, 8.8	Low/Middle/ High	ANNEX A.7	Pass	Note [2]
9	Radiated Spurious Emission	15.209 15.247(d)	RSS-247, 5.5	Low/Middle/ High	ANNEX A.8	Pass	Note [2]
10	Band Edge(Restricted-band band-edge)	15.209 15.247(d)	RSS-247, 5.5	Low/Middle/ High	ANNEX A.9	Pass	Note [2]
11	Receiver Spurious Emissions	--	RSS-Gen, 7.3	--	--	N/A	Note [3]

Note [1]: Please refer to section 5.1

Note [2]: π/4-DQPSK is the EDR 2M rate mode, 8-DPSK is the EDR 3M rate mode. The consistency of test results in π/4-DQPSK and 8-DPSK is very high. So we chose 8-DPSK as a typical representative to appear on the report. Another we will show all the modes on the RF output power test item.

Note [3]: Only radio communication receivers operating in stand-alone mode within the band 30-960 MHz, as well as scanner receivers, are subject to Industry Canada requirements, so this test is not applicable.

4 GENERAL TEST CONFIGURATIONS

4.1 Test Environments

During the measurement, the normal environmental conditions were within the listed ranges:

Relative Humidity	45% to 55%	
Atmospheric Pressure	100 kPa to 102 kPa	
Temperature	NT (Normal Temperature)	+22℃ to +25℃
Working Voltage of the EUT	NV (Normal Voltage)	7.7 V

4.2 Test Equipment List

Description	Manufacturer	Model	Serial No.	Cal. Date	Cal. Due
Spectrum Analyzer	ROHDE&SCHWARZ	FSV-40	101544	2021.04.01	2022.03.31
Bluetooth Signaling Unit	ROHDE&SCHWARZ	CMW500	142028	2021.06.01	2022.05.31
EMI Receiver	KEYSIGHT	N9038A	MY53220118	2021.06.01	2022.05.31
EMI Receiver	ROHDE&SCHWARZ	ESRP	101036	2021.06.01	2022.05.31
LISN	SCHWARZBECK	NSLK 8127	8127-687	2021.06.01	2022.05.31
Test Antenna-Loop(9 kHz-30 MHz)	SCHWARZBECK	FMZB 1519	1519-037	2021.04.16	2024.04.15
Test Antenna-Bi-Log(30 MHz-3 GHz)	SCHWARZBECK	VULB 9163	9163-624	2021.08.20	2024.08.19
Test Antenna-Horn(1-18 GHz)	SCHWARZBECK	BBHA 9120D	9120D-1917	2019.07.02	2022.07.01
Test Antenna-Horn (18-40 GHz)	A-INFO	LB-180400KF	J211060273	2021.07.02	2023.07.01
Anechoic Chamber	RAINFORD	9m*6m*6m	N/A	2017.02.21	2022.02.20
Anechoic Chamber	EMC Electronic Co., Ltd	20.10*11.60 *7.35m	N/A	2019.08.08	2022.08.07
Shielded Enclosure	ChangNing	CN-130701	130703	--	--

4.3 Test Software List

Description	Manufacturer	Software Version	Serial No.	Applicable test Setup
BL410R	BALUN	V2.1.1.488	N/A	The section 4.5.1
BL410E	BALUN	V19.8.28.435	N/A	The section 4.5.2&4.5.3&4.5.4&4.5.5

4.4 Measurement Uncertainty

The following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2.

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

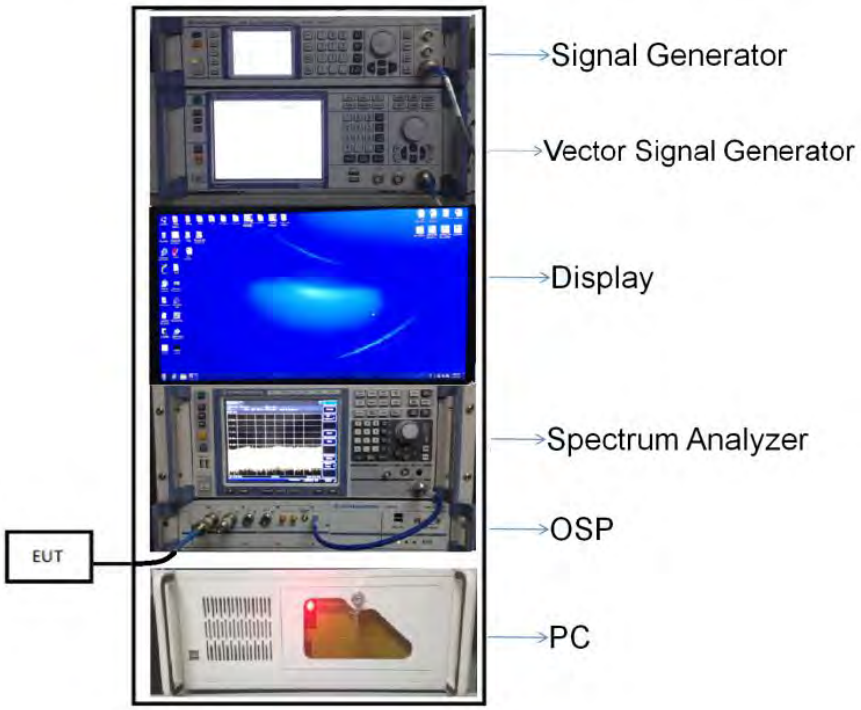
Parameters	Uncertainty
Occupied Channel Bandwidth	2.8%
RF output power, conducted	1.28 dB
Power Spectral Density, conducted	1.30 dB
Unwanted Emissions, conducted	1.84 dB
All emissions, radiated	5.36 dB
Temperature	0.82℃
Humidity	4.1%

4.5 Description of Test Setup

4.5.1 For Antenna Port Test

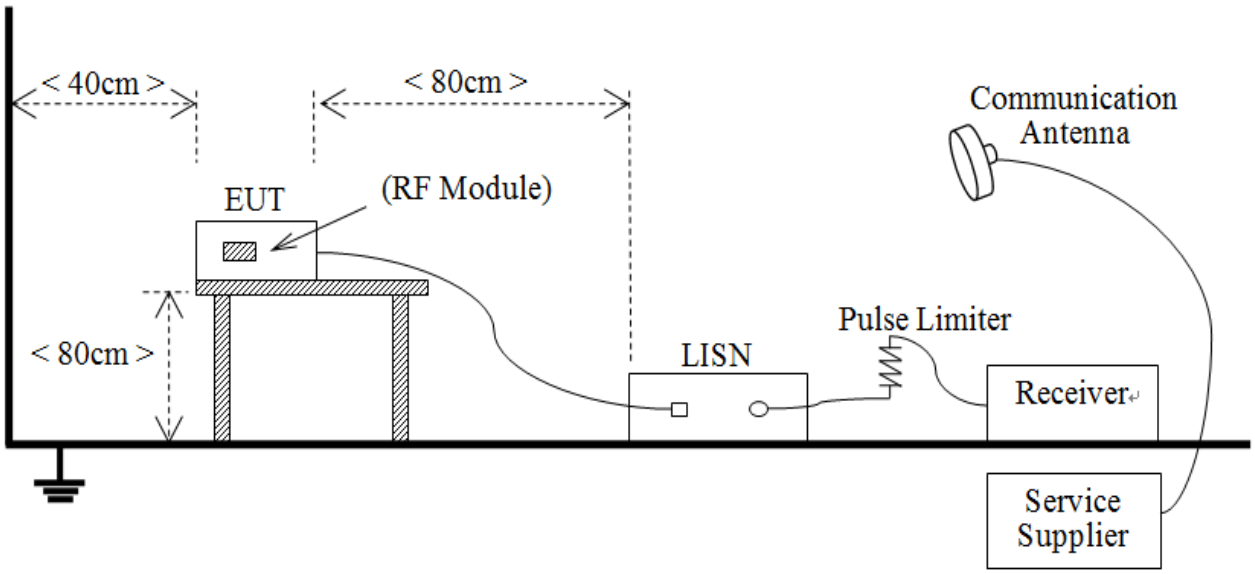
Conducted value (dBm) = Measurement value (dBm) + cable loss (dB)

For example: the measurement value is 10 dBm and the cable 0.5dBm used, then the final result of EUT:
Conducted value (dBm) = 10 dBm + 0.5 dB = 10.5 dBm



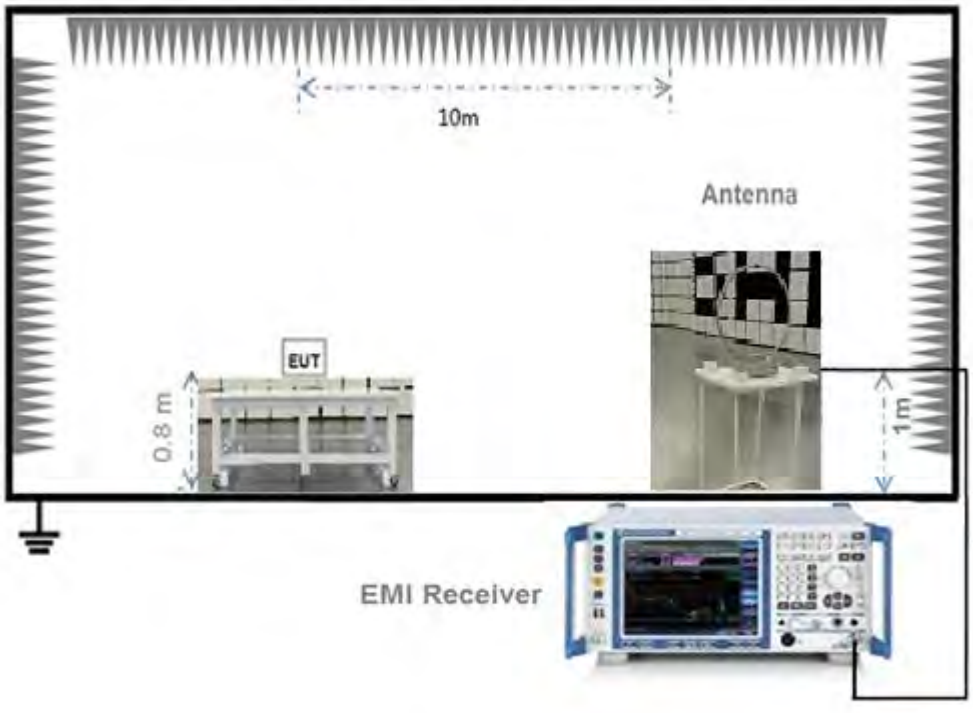
(Diagram 1)

4.5.2 For AC Power Supply Port Test



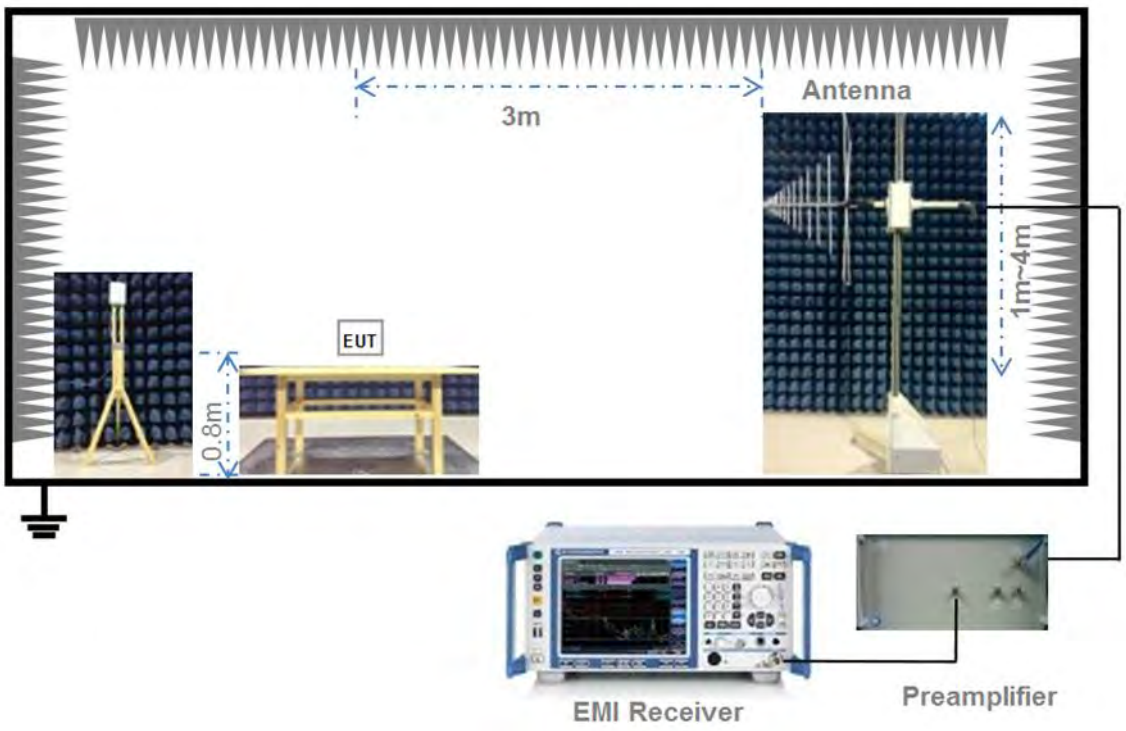
(Diagram 2)

4.5.3 For Radiated Test (Below 30 MHz)



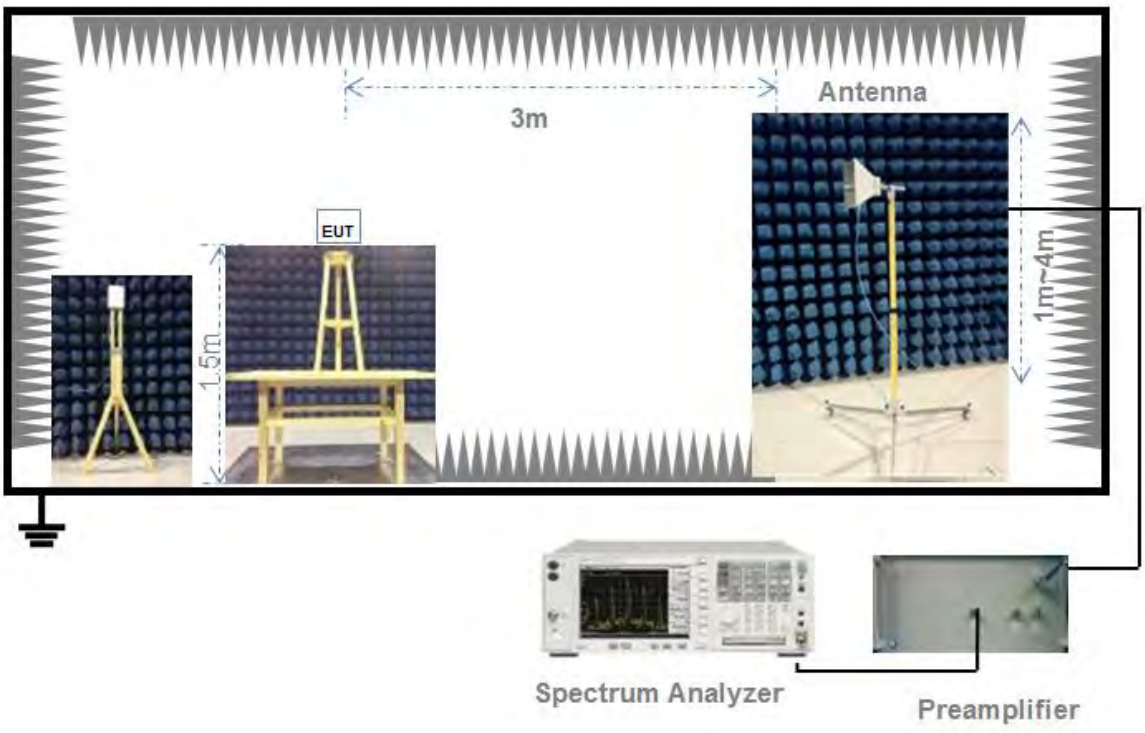
(Diagram 3)

4.5.4 For Radiated Test (30 MHz-1 GHz)



(Diagram 4)

4.5.5 For Radiated Test (Above 1 GHz)



(Diagram 5)

4.6 Measurement Results Explanation Example

4.6.1 For conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.
The spectrum analyzer offset is derived from RF cable loss and attenuator factor.
Offset = RF cable loss + attenuator factor.

5 TEST ITEMS

5.1 Antenna Requirements

5.1.1 Relevant Standards

FCC §15.203 & 15.247(b); RSS-247, 5.4 (f)

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of § 15.211, § 15.213, § 15.217, § 15.219, or § 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with § 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

If directional gain of transmitting antennas is greater than 6 dBi, the power shall be reduced by the same level in dB comparing to gain minus 6 dBi. For the fixed point-to-point operation, the power shall be reduced by one dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the FCC rule.

5.1.2 Antenna Anti-Replacement Construction

The Antenna Anti-Replacement as following method:

Protected Method	Description
The antenna is embedded in the product.	An embedded-in antenna design is used.

Reference Documents	Item
Photo	Please refer to the EUT Photo documents.

5.1.3 Antenna Gain

The antenna peak gain of EUT is less than 6 dBi. Therefore, it is not necessary to reduce maximum peak output power limit.

5.2 Frequency Hopping Systems

5.2.1 Relevant Standards

FCC §15.247(a) (1) (i) (ii) (iii) (iv); FCC §15.247(g); FCC §15.247(h)

Describe how the hopping sequence is generated. Provide an example of the hopping sequence channels, to demonstrate that the sequence meets the requirement specified in the definition of an FHSS system. Per the definition in Section 2.1(c), the hop set shall appear as random in the near term, shall appear as evenly distributed in the long term, and sequential hops shall be randomly distributed in both direction and magnitude of change.

Describe how each individual EUT meets the requirement that each of its hopping channels is used equally on average (e.g., that each new transmission event begins on the next channel in the hopping sequence after the final channel used in the previous transmission event).

Describe how the associated receiver(s) complies with the requirement that the input bandwidth (either RF or IF) matches the bandwidth of the transmitted signal.

Describe how the associated receiver(s) has the ability to shift frequencies in synchronization with the transmitted signals.

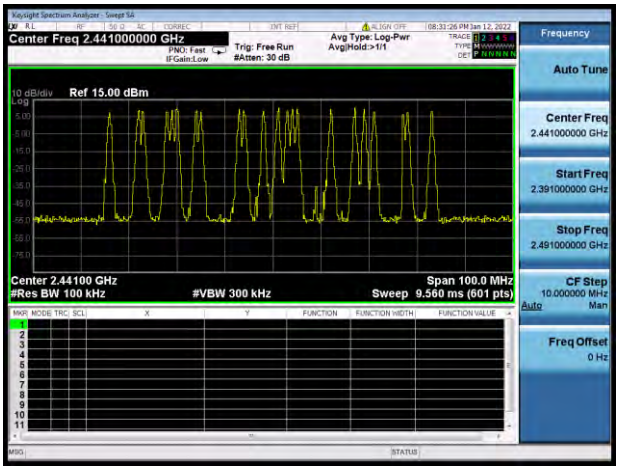
For short burst systems, describe how the EUT complies with the requirement that it be designed to be capable of operating as a true frequency hopping system. Specifically, the device shall comply with the equal frequency use and pseudorandom hopping sequence requirement when transmitting in short bursts, and shall be designed to comply when presented with continuous data (or information) stream.

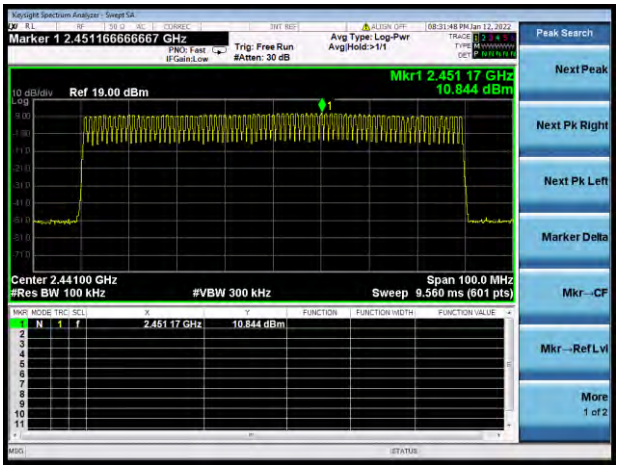
Describe how the EUT complies with the requirement that it not have the ability to be coordinated with other FHSS systems in an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitters.

5.2.2 Description of the systems

1. According to the preset procedure of the whole network, all the stations in the automatic control network synchronously change the frequency multiple times within one second, and temporarily stay on each frequency hopping channel. Periodic synchronization signaling is sent from the primary station, instructing all slaves to simultaneously change the operating frequency, then the hopping sequence is generated.
2. The hop set shall appear as random in the near term, shall appear as evenly distributed in the long term, and sequential hops shall be randomly distributed in both direction and magnitude of change.

Reference Documents





3. Channels are classified into two categories, used and unused, where used channels are part of the hopping sequence and unused channels are replaced in the hopping sequence by used channels in a pseudo-random way. Make each individual EUT meets the requirement that each of its hopping channels is used equally on average.
4. The input bandwith and transmitted bandwith are both 1MHz, the associated receiver(s) complies with the requirement that the input bandwidth matches the bandwidth of the transmitted signal.
5. Connected devices communicate on the same physical channel by synchronizing with a common clock and hopping sequence.
6. EUT isn’t short burst systems.
7. EUT can’t have the ability to be coordinated with other FHSS systems in an effort.

5.3 Number of Hopping Frequencies

5.3.1 Limit

FCC §15.247(a) (1) (iii); RSS-247, 5.1 (d)

Frequency hopping systems operating in the 2400 MHz to 2483.5 MHz bands shall use at least 15 hopping frequencies.

5.3.2 Test Setup

See section 4.5.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.3.3 Test Procedure

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

Span = The frequency band of operation

RBW = To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.

VBW ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize

5.3.4 Test Result

Please refer to ANNEX A.1.

5.4 Peak Output Power and E.I.R.P

5.4.1 Test Limit

FCC § 15.247(b)

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

RSS-247, 5.4 (b)

For FHSs operating in the band 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1.0 W and the e.i.r.p. shall not exceed 4 W if the hopset uses 75 or more hopping channels; the maximum peak conducted output power shall not exceed 0.125 W and the e.i.r.p. shall not exceed 0.5 W if the hopset uses less than 75 hopping channels (see Section 5.4(5) for exceptions).

5.4.2 Test Setup

See section 4.5.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.4.3 Test Procedure

The Module operates at hopping-off test mode. The lowest, middle and highest channels are selected to perform testing to verify the conducted RF output peak power of the Module.

Use the following spectrum analyzer settings:

Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel

RBW > the 20 dB bandwidth of the emission being measured

VBW ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize.

5.4.4 Test Result

Please refer to ANNEX A.2.

5.5 Occupied Bandwidth

5.5.1 Limit

FCC §15.247(a); RSS-247, 5.1 (a)

Measurement of the 20dB bandwidth of the modulated signal.

5.5.2 Test Setup

See section 4.5.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.5.3 Test Procedure

Use the following spectrum analyzer settings:

Span = approximately 2 to 5 times the 20 dB bandwidth, centered on a hopping channel

RBW = in the range of 1% to 5% of the OBW

VBW ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

The EUT should be transmitting at its maximum data rate, Allow the trace to stabilize.

5.5.4 Test Result

Please refer to ANNEX A.3.

5.6 Carrier Frequency Separation

5.6.1 Limit

FCC §15.247(a); RSS-247, 5.1 (b)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 2/3 of the 20 dB bandwidth of the hopping channel, whichever is greater.

5.6.2 Test Setup

See section 4.5.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.6.3 Test Procedure

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

Span = wide enough to capture the peaks of two adjacent channels

Resolution (or IF) Bandwidth (RBW) ≥ 1% of the span

Video (or Average) Bandwidth (VBW) ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

5.6.4 Test Result

Please refer to ANNEX A.4.

5.7 Time of Occupancy (Dwell time)

5.7.1 Limit

FCC §15.247(a); RSS-247, 5.1 (d)

Frequency hopping systems in the 2400 MHz - 2483.5 MHz band shall use at least 15 non-overlapping channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

5.7.2 Test Setup

See section 4.5.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.7.3 Test Procedure

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:
Span: Zero span, centered on a hopping channel
RBW shall be ≤ channel spacing and where possible RBW should be set >> 1 / T, where T is the expected dwell time per channel
Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel
Detector function: Peak
Trace: Max hold

Use the marker-delta function to determine the transmit time per hop. If this value varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation in transmit time.

The average time of occupancy on any channel within the Period can be calculated with formulas:
For GFSK and 8-DPSK:
For DH1 package type

{Total of Dwell} = {Pulse Time} * (1600 / 2) / {Number of Hopping Frequency} * {Period}
{Period} = 0.4 s * {Number of Hopping Frequency}

For DH3 package type

{Total of Dwell} = {Pulse Time} * (1600 / 4) / {Number of Hopping Frequency} * {Period}
{Period} = 0.4 s * {Number of Hopping Frequency}

For DH5 package type

{Total of Dwell} = {Pulse Time} * (1600 / 6) / {Number of Hopping Frequency} * {Period}
{Period} = 0.4 s * {Number of Hopping Frequency}

For AFH Mode:
For DH1 package type

{Total of Dwell} = {Pulse Time} * (800 / 2) / {Number of Hopping Frequency} * {Period}
{Period} = 0.4 s * {Number of Hopping Frequency}

For DH3 package type

{Total of Dwell} = {Pulse Time} * (800 / 4) / {Number of Hopping Frequency} * {Period}
{Period} = 0.4 s * {Number of Hopping Frequency}

For DH5 package type

{Total of Dwell} = {Pulse Time} * (800 / 6) / {Number of Hopping Frequency} * {Period}

{Period} = 0.4 s * {Number of Hopping Frequency}

The lowest, middle and highest channels are selected to perform testing to record the dwell time of each occupation measured in this channel, which is called Pulse Time here.

5.7.4 Test Result

Please refer to ANNEX A.5.

5.8 Conducted Spurious Emission & Authorized-band band-edge

5.8.1 Limit

FCC §15.247(d); RSS-247, 5.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

5.8.2 Test Setup

See section 4.5.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.8.3 Test Procedure

Use the following spectrum analyzer settings:

Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.
RBW = 100 kHz
VBW = 300 kHz
Sweep = auto
Detector function = peak
Trace = max hold
Allow the trace to stabilize

5.8.4 Test Result

Please refer to ANNEX A.6.

5.9 Conducted Emission

5.9.1 Limit

FCC §15.207; RSS-GEN, 8.8

For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50μH/50Ω line impedance stabilization network (LISN).

Frequency range (MHz)	Conducted Limit (dBμV)	
	Quai-peak	Average
0.15 - 0.50	66 to 56	56 to 46
0.50 - 5	56	46
0.50 - 30	60	50

5.9.2 Test Setup

See section 4.5.2 for test setup description for the AC power supply port. The photo of test setup please refer to ANNEX B.

5.9.3 Test Procedure

The maximum conducted interference is searched using Peak (PK), if the emission levels more than the AV and QP limits, and that have narrow margins from the AV and QP limits will be re-measured with AV and QP detectors. Tests for both L phase and N phase lines of the power mains connected to the EUT are performed. Refer to recorded points and plots below.
Devices subject to Part 15 must be tested for all available U.S. voltages and frequencies (such as a nominal 120 VAC, 50/60 Hz and 240 VAC, 50/60 Hz) for which the device is capable of operation. A device rated for 50/60 Hz operation need not be tested at both frequencies provided the radiated and line conducted emissions are the same at both frequencies.

5.9.4 Test Result

Please refer to ANNEX A.7.

5.10 Radiated Spurious Emission

5.10.1 Limit

FCC §15.209&15.247(d); RSS-247, 5.5

Radiated emission outside the frequency band attenuation below the general limits specified in FCC section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in FCC section 15.205(a), must also comply with the radiated emission limits specified in FCC section 15.209(a).

According to FCC section 15.209 (a), except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength (μV/m)	Measurement Distance (m)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100	3
88 - 216	150	3
216 - 960	200	3
Above 960	500	3

Note:

1. Field Strength (dBμV/m) = 20*log[Field Strength (μV/m)].
2. In the emission tables above, the tighter limit applies at the band edges.
3. For Above 1000 MHz, the emission limit in this paragraph is based on measurement instrumentation employing an average detector, measurement using instrumentation with a peak detector function, corresponding to 20dB above the maximum permitted average limit.
4. For above 1000 MHz, limit field strength of harmonics: 54dBuV/m@3m (AV) and 74dBuV/m@3m (PK).

5.10.2 Test Setup

See section 4.5.3 to 4.5.5 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.10.3 Test Procedure

The measurement frequency range is from 9 kHz to the 10th harmonic of the fundamental frequency. The Turn Table is actuated to turn from 0° to 360°, and both horizontal and vertical polarizations of the Test Antenna are used to find the maximum radiated power. Mid channels on all channel bandwidth verified. Only the worst RB size/offset presented.

The power of the EUT transmitting frequency should be ignored.

All Spurious Emission tests were performed in X, Y, Z axis direction. And only the worst axis test condition was recorded in this test report.

Use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured
RBW = 1 MHz for f ≥ 1 GHz, 100 kHz for f < 1 GHz
VBW ≥ RBW

Sweep = auto
Detector function = peak
Trace = max hold
For measurement below 1GHz, If the emission level of the EUT measured by the peak detector is 3 dB lower than the applicable limit, the peak emission level will be reported, Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.

5.10.4 Test Result

Please refer to ANNEX A.8.

5.11 Band Edge (Restricted-band band-edge)

5.11.1 Limit

FCC §15.209&15.247(d)

Radiated emission outside the frequency band attenuation below the general limits specified in FCC section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in FCC section 15.205(a), must also comply with the radiated emission limits specified in FCC section 15.209(a).

5.11.2 Test Setup

See section 4.5.3 to 4.5.5 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.11.3 Test Procedure

The measurement frequency range is from 9 kHz to the 10th harmonic of the fundamental frequency. The Turn Table is actuated to turn from 0° to 360°, and both horizontal and vertical polarizations of the Test Antenna are used to find the maximum radiated power. Mid channels on all channel bandwidth verified. Only the worst RB size/offset presented.

The power of the EUT transmitting frequency should be ignored.

All Spurious Emission tests were performed in X, Y, Z axis direction. And only the worst axis test condition was recorded in this test report.

Use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured
RBW = 1 MHz for f ≥ 1 GHz, 100 kHz for f < 1 GHz
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

For measurement below 1GHz, If the emission level of the EUT measured by the peak detector is 3 dB lower than the applicable limit, the peak emission level will be reported, Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.

5.11.4 Test Result

Please refer to ANNEX A.9.

ANNEX A TEST RESULT

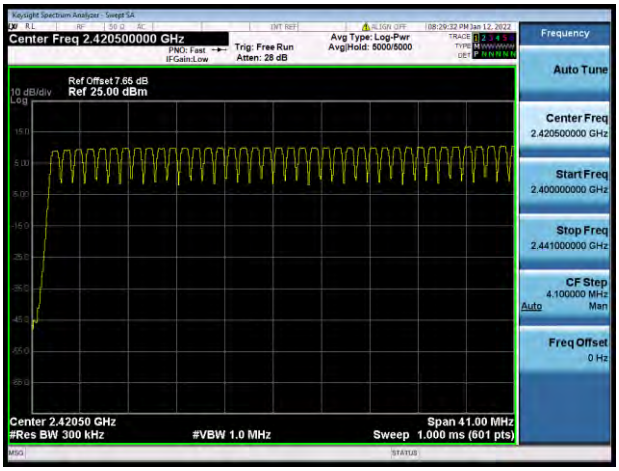
A.1 Number of Hopping Frequency

Test Data

Test Mode	Frequency Block (MHz)	Measured Channel Numbers	Min. Limit	Verdict
GFSK	2400 - 2483.5	79	15	Pass
8-DPSK	2400 - 2483.5	79	15	Pass

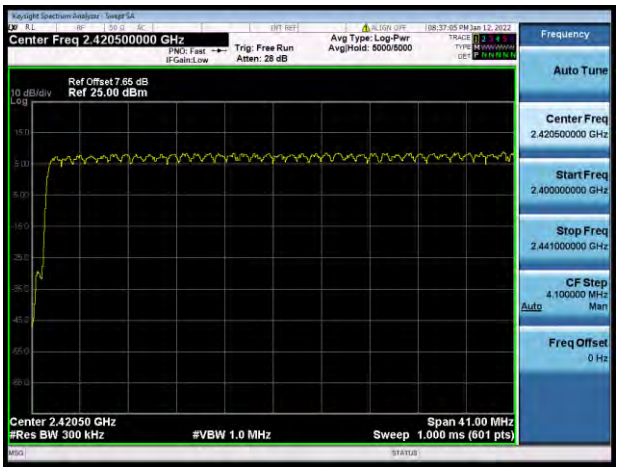
Test Plots

GFSK 2.4 GHz ~ 2.4415 GHz



GFSK 2.4415 GHz ~ 2.4835 GHz

8-DPSK 2.4 GHz ~ 2.4415 GHz



8-DPSK 2.4415 GHz ~ 2.4835 GHz

A.2 Peak Output Power and E.I.R.P

Peak Power Test Data

Channel	Measured Output Peak Power		Limit		Verdict
	GFSK		dBm	mW	
	dBm	mW			
Low	9.10	8.13	21	125	Pass
Middle	10.67	11.66			Pass
High	9.10	8.12			Pass

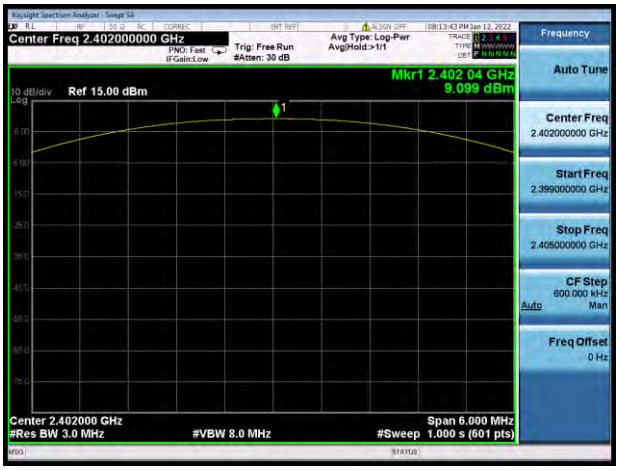
Channel	Measured Output Peak Power				Limit		Verdict
	π/4-DQPSK		8-DPSK		dBm	mW	
	dBm	mW	dBm	mW			
Low	9.17	8.26	9.49	8.90	21	125	Pass
Middle	10.72	11.80	11.03	12.66			Pass
High	9.03	8.00	9.30	8.51			Pass

E.I.R.P Test Data (For ISED)

Channel	E.I.R.P						Limit		Verdict
	GFSK		π/4-DQPSK		8-DPSK		dBm	mW	
	dBm	mW	dBm	mW	dBm	mW			
Low	10.95	12.44	11.02	12.65	11.34	13.62	36	4000	Pass
Middle	12.52	17.86	12.57	18.06	12.88	19.39			Pass
High	10.95	12.44	10.88	12.24	11.15	13.03			Pass

Test Plots

GFSK LOW CHANNEL



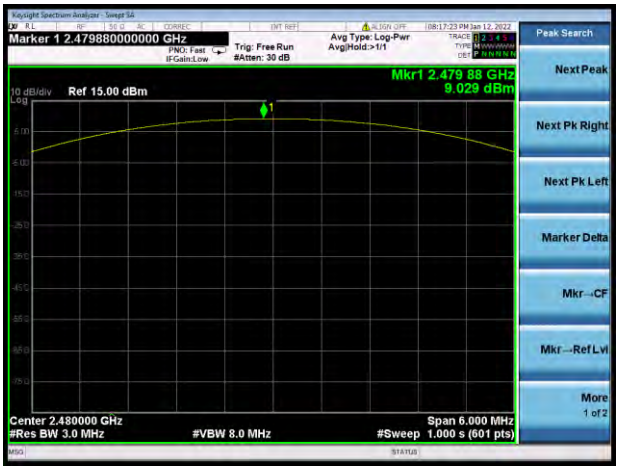
GFSK MIDDLE CHANNEL

GFSK HIGH CHANNEL

π/4-DQPSK LOW CHANNEL

π/4-DQPSK MIDDLE CHANNEL

π/4-DQPSK HIGH CHANNEL



8-DPSK LOW CHANNEL

8-DPSK MIDDLE CHANNEL

8-DPSK HIGH CHANNEL

A.3 20 dB and 99% bandwidth

Test Data

GFSK		
Channel	20 dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	0.945000	0.825360
Middle	0.940000	0.825750
High	0.940000	0.827890
π/4-DQPSK		
Channel	20 dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	1.285000	1.175500
Middle	1.285000	1.175600
High	1.285000	1.180700
8-DPSK		
Channel	20 dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	1.295000	1.175600
Middle	1.295000	1.176500
High	1.295000	1.181300

Test Plots

20 dB Bandwidth

GFSK LOW CHANNEL

GFSK MIDDLE CHANNEL

GFSK HIGH CHANNEL

π/4-DQPSK LOW CHANNEL

π/4-DQPSK MIDDLE CHANNEL

π/4-DQPSK HIGH CHANNEL

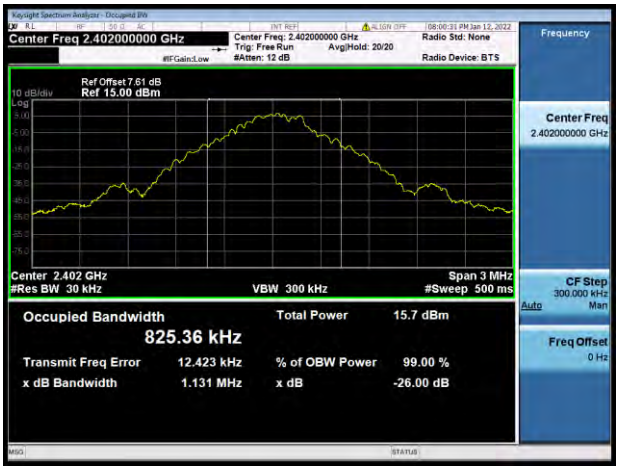
8-DPSK LOW CHANNEL

8-DPSK MIDDLE CHANNEL

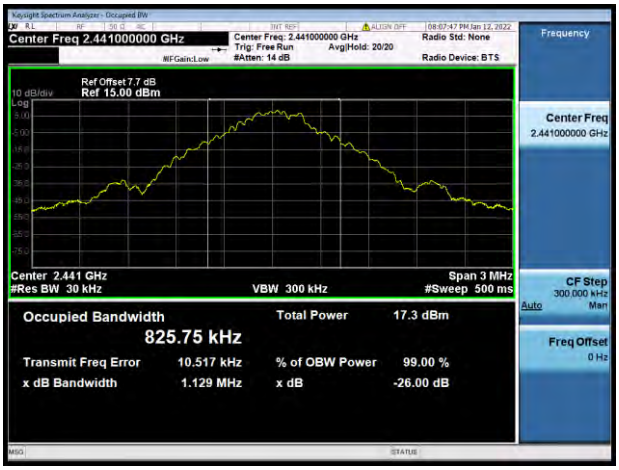
8-DPSK HIGH CHANNEL

99% Bandwidth

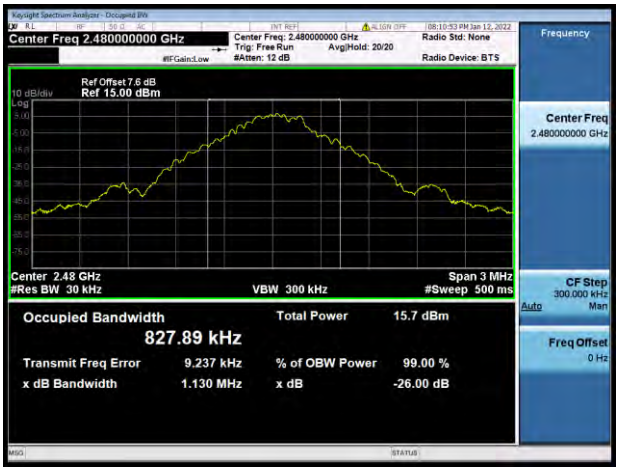
GFSK LOW CHANNEL



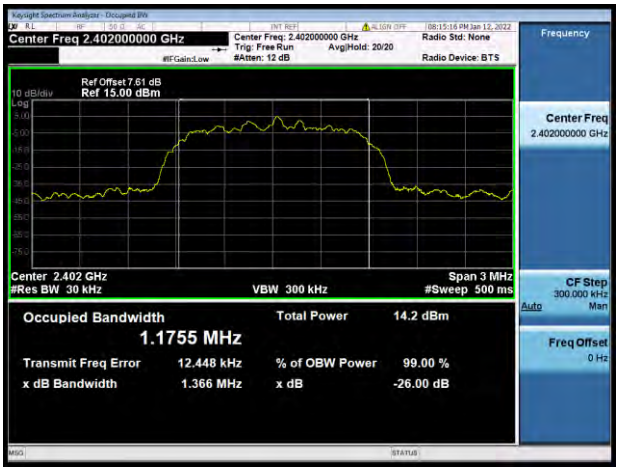
GFSK MIDDLE CHANNEL



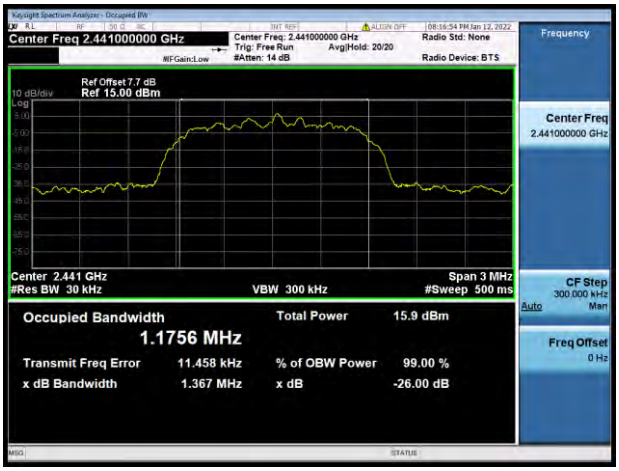
GFSK HIGH CHANNEL



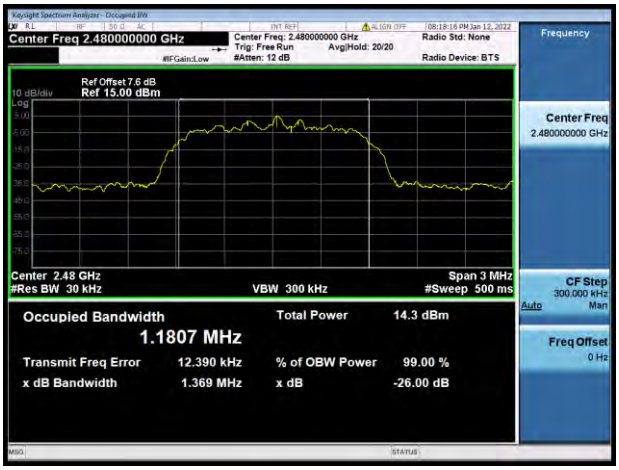
π/4-DQPSK LOW CHANNEL



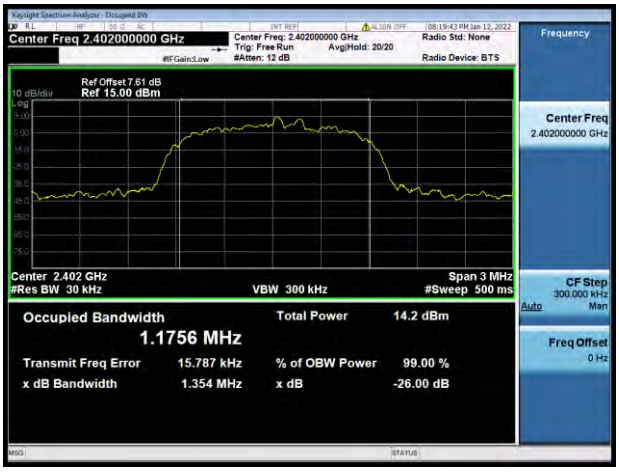
π/4-DQPSK MIDDLE CHANNEL



π/4-DQPSK HIGH CHANNEL

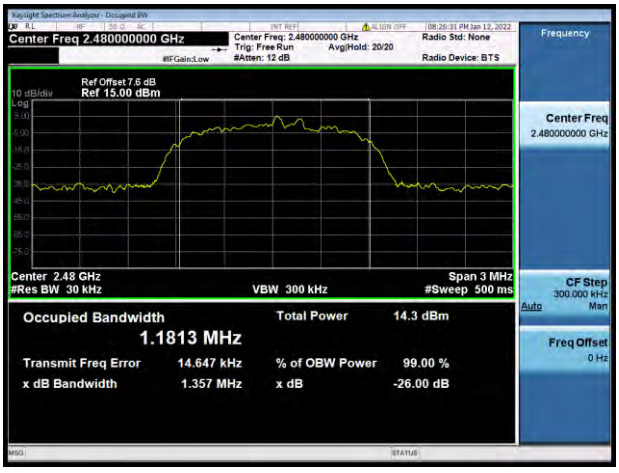


8-DPSK LOW CHANNEL



8-DPSK MIDDLE CHANNEL

8-DPSK HIGH CHANNEL



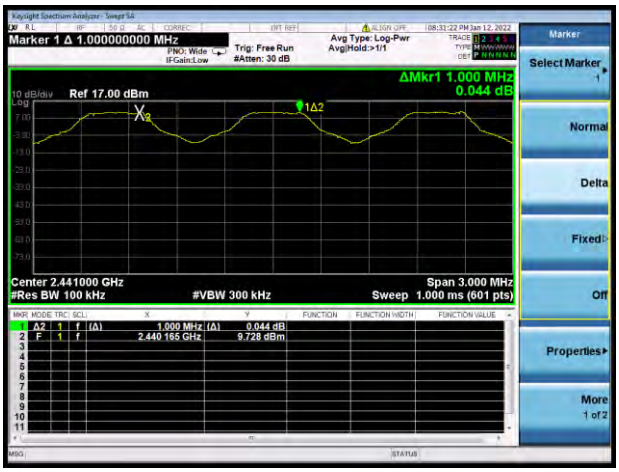
A.4 Hopping Frequency Separation

Test Data

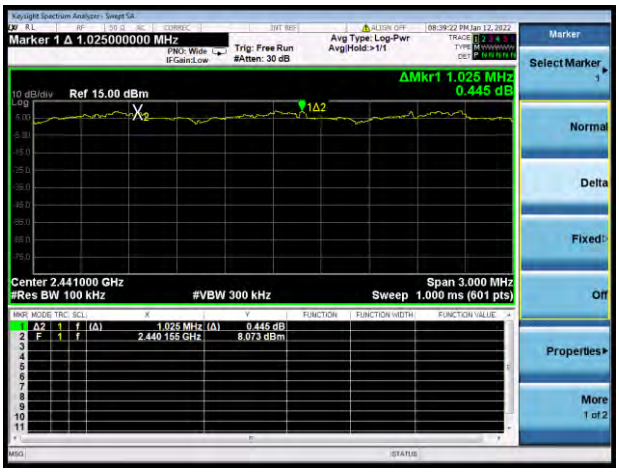
Mode	Frequency separation (MHz)	2/3 of the 20 dB Bandwidth (MHz)	Verdict
GFSK	1.000	0.630000	Pass
8-DPSK	1.025	0.863333	Pass

Test Plots

GFSK



8-DPSK



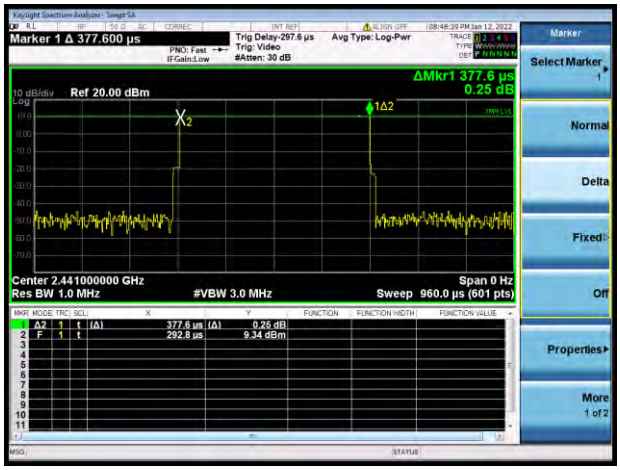
A.5 Average Time of Occupancy

Test Data

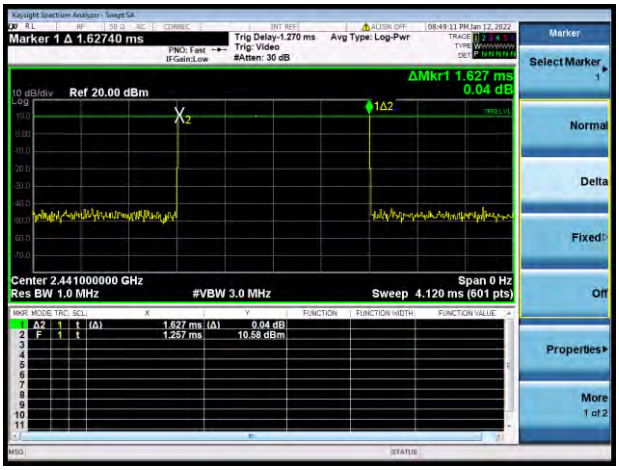
GFSK				
DH Packet	Pulse Width (ms)	Total of Dwell (ms)	Limit (sec)	Verdict
DH 1	0.37760	120.832	0.4	Pass
DH 3	1.62700	260.320	0.4	Pass
DH 5	2.88800	308.053	0.4	Pass
8-DPSK				
DH Packet	Pulse Width (ms)	Total of Dwell (ms)	Limit (sec)	Verdict
DH 1	0.38240	122.368	0.4	Pass
DH 3	1.63400	261.440	0.4	Pass
DH 5	2.88800	308.053	0.4	Pass
AFH Mode				
DH Packet	Pulse Width (ms)	Total of Dwell (ms)	Limit (sec)	Verdict
DH 1	0.37600	60.160	0.4	Pass
DH 3	1.62100	129.680	0.4	Pass
DH 5	2.87600	153.387	0.4	Pass

Test Plots

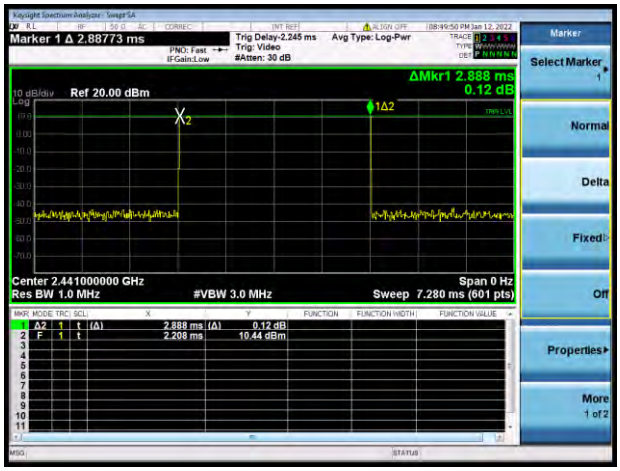
GFSK DH1



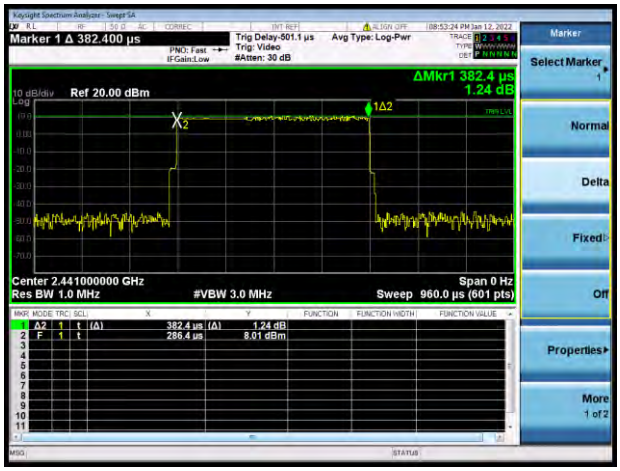
GFSK DH3



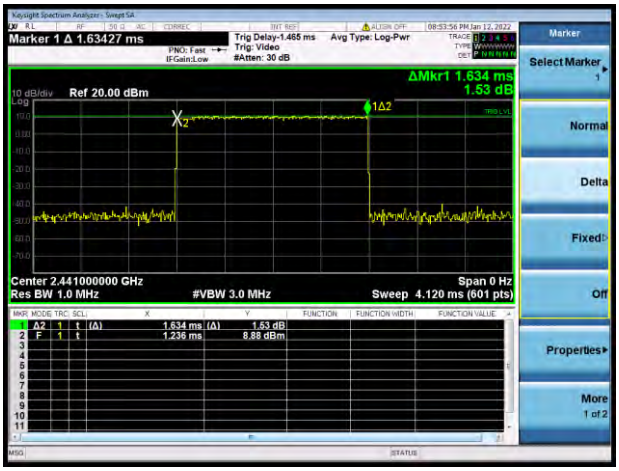
GFSK DH5



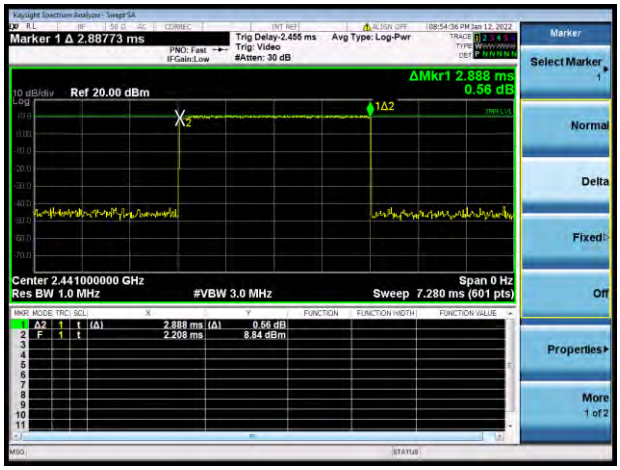
8-DPSK DH1



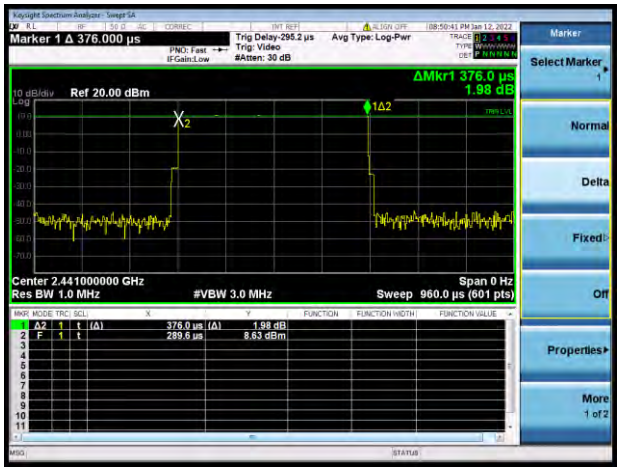
8-DPSK DH3



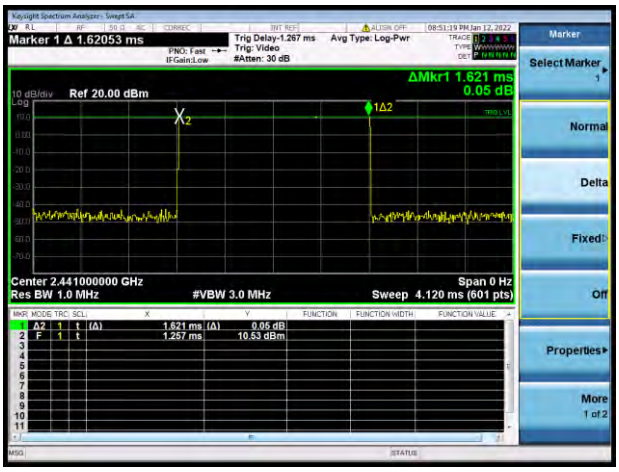
8-DPSK DH5



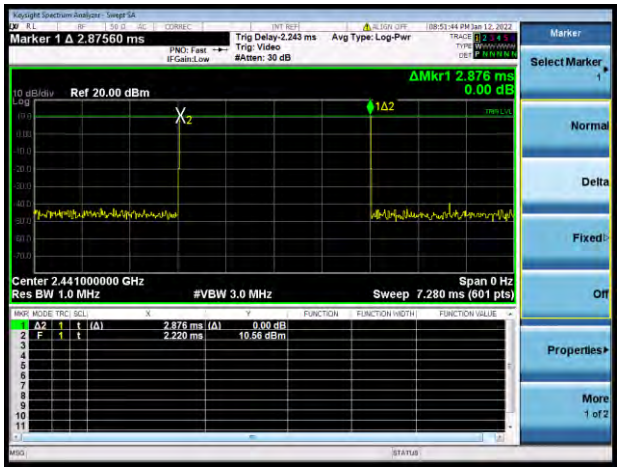
AFH Mode DH1



AFH Mode DH3



AFH Mode DH5



A.6 Conducted Spurious Emissions & Authorized-band band-edge

Test Data

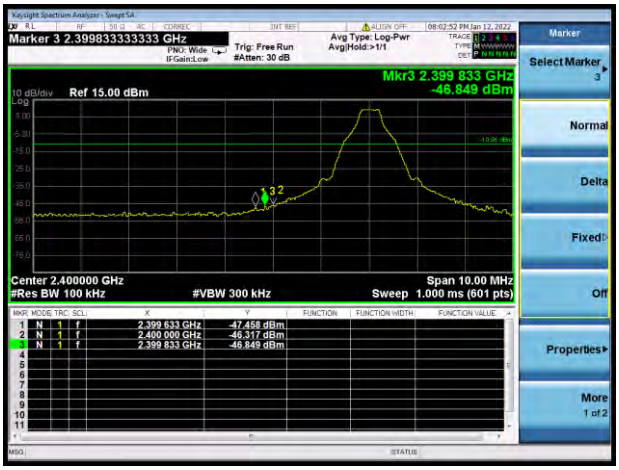
GFSK				
Channel	Measured Max. Out of Band Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
Low	-36.09	9.04	-10.96	Pass
Middle	-36.11	10.59	-9.41	Pass
High	-35.85	8.98	-11.03	Pass
8-DPSK				
Channel	Measured Max. Out of Band Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
Low	-35.35	7.25	-12.75	Pass
Middle	-35.85	8.86	-11.14	Pass
High	-36.03	7.38	-12.62	Pass

Hopping Mode				
Mode	Measured Max. Out of Band Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
GFSK	-35.41	10.84	-9.16	Pass
8-DPSK	-35.52	8.34	-11.66	Pass

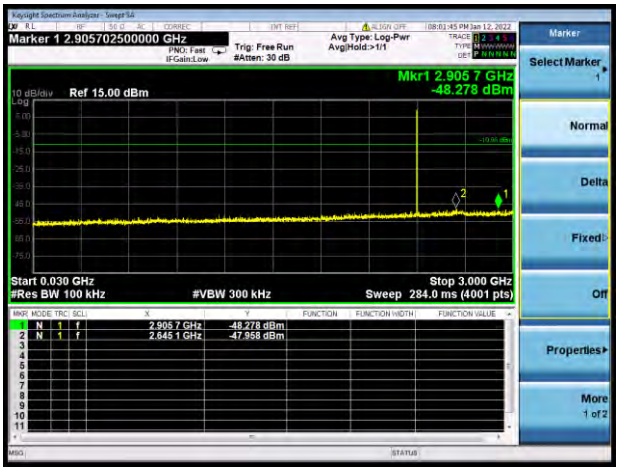
Test Plots

GFSK LOW CHANNEL, CARRIER LEVEL

GFSK LOW CHANNEL, BAND EDGE



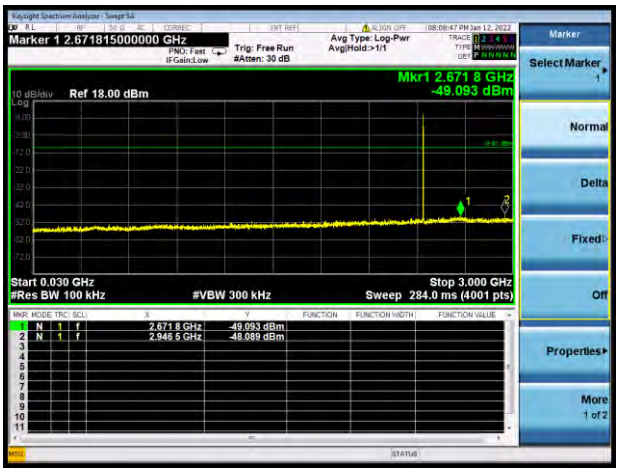
GFSK LOW CHANNEL, SPURIOUS 30 MHz ~ 3 GHz



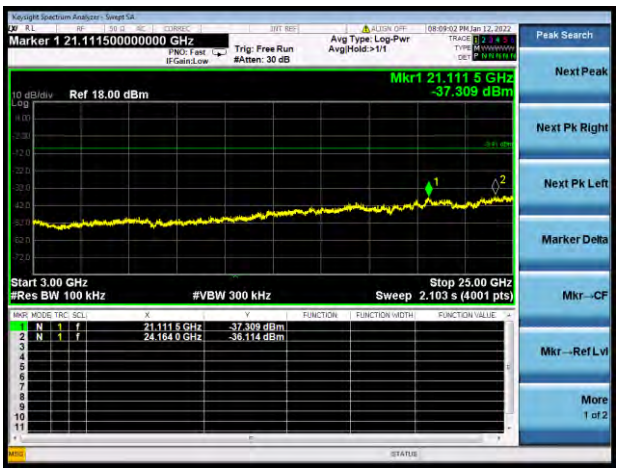
GFSK LOW CHANNEL, SPURIOUS 3 GHz ~ 25 GHz

GFSK MIDDLE CHANNEL, CARRIER LEVEL

GFSK MIDDLE CHANNEL, SPURIOUS 30 MHz ~ 3 GHz

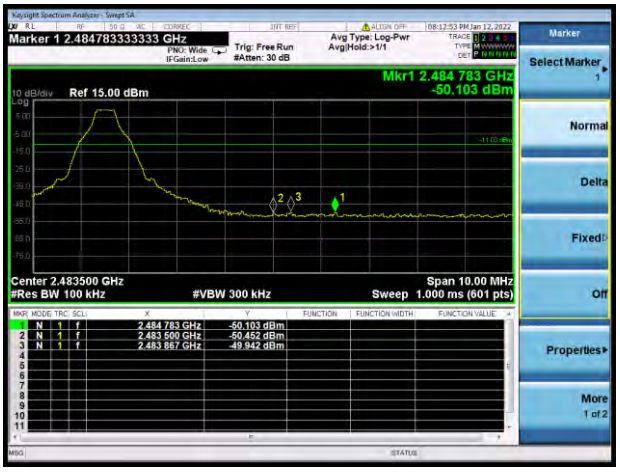


GFSK MIDDLE CHANNEL, SPURIOUS 3 GHz ~ 25 GHz

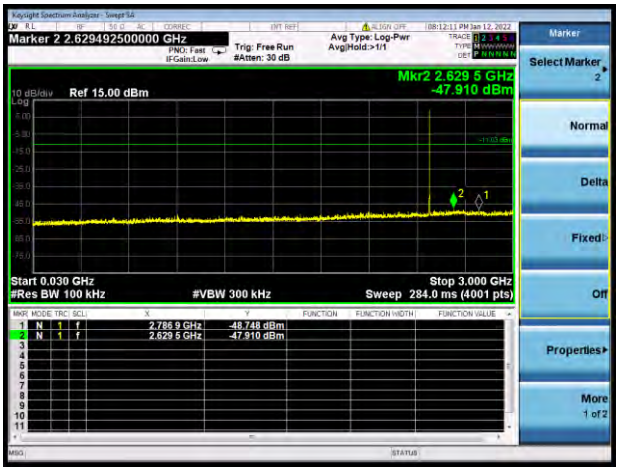


GFSK HIGH CHANNEL, CARRIER LEVEL

GFSK HIGH CHANNEL, BAND EDGE



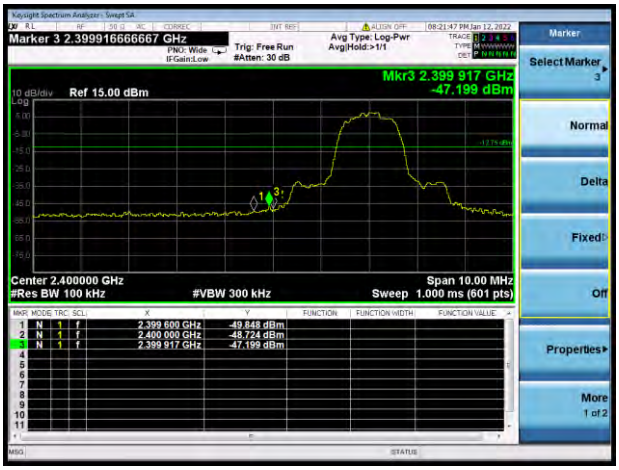
GFSK HIGH CHANNEL, SPURIOUS 30 MHz ~ 3 GHz



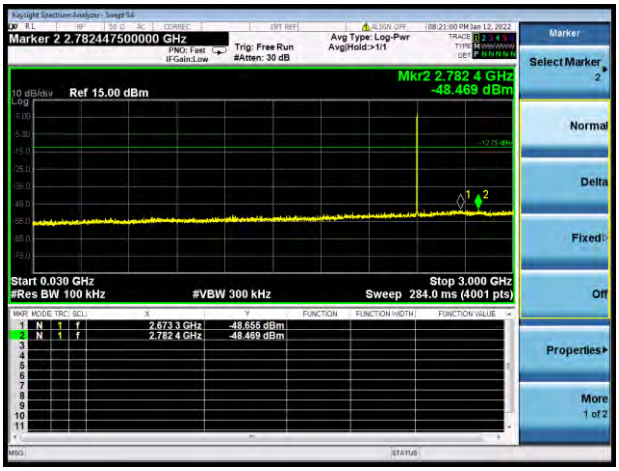
GFSK HIGH CHANNEL, SPURIOUS 3 GHz ~ 25 GHz

8-DPSK LOW CHANNEL, CARRIER LEVEL

8-DPSK LOW CHANNEL, BAND EDGE



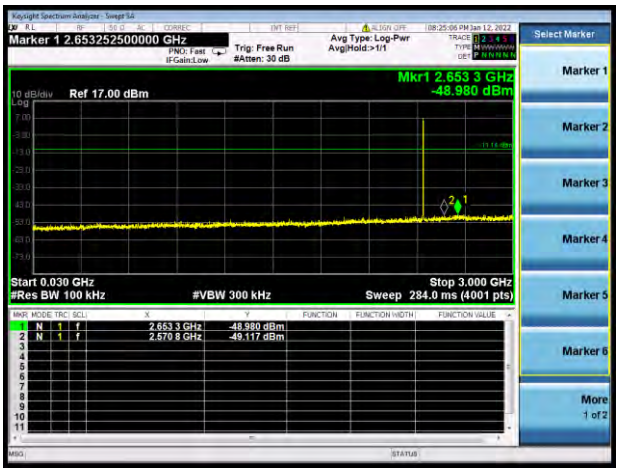
8-DPSK LOW CHANNEL, SPURIOUS 30 MHz ~ 3 GHz



8-DPSK LOW CHANNEL, SPURIOUS 3 GHz ~ 25 GHz

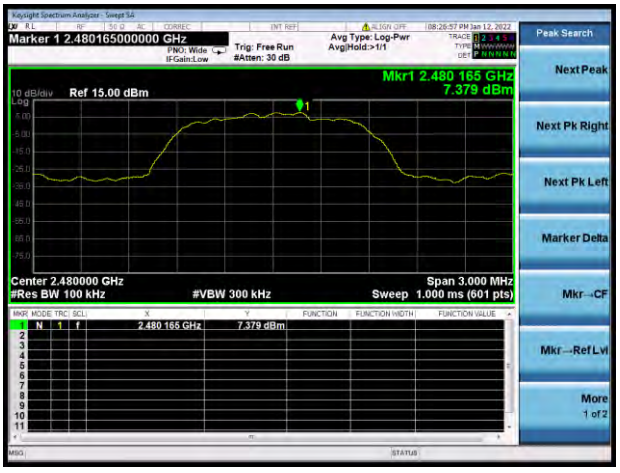
8-DPSK MIDDLE CHANNEL, CARRIER LEVEL

8-DPSK MIDDLE CHANNEL, SPURIOUS 30 MHz ~ 3 GHz

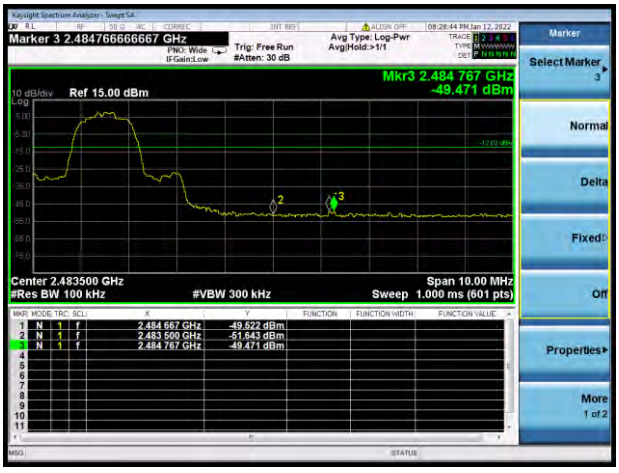


8-DPSK MIDDLE CHANNEL, SPURIOUS 3 GHz ~ 25 GHz

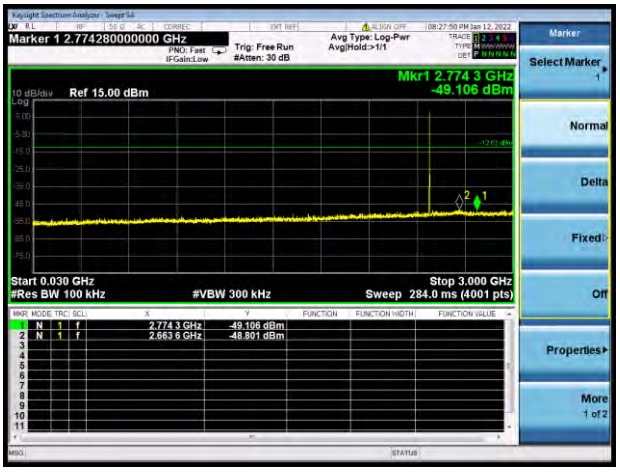
8-DPSK HIGH CHANNEL, CARRIER LEVEL



8-DPSK HIGH CHANNEL, BAND EDGE

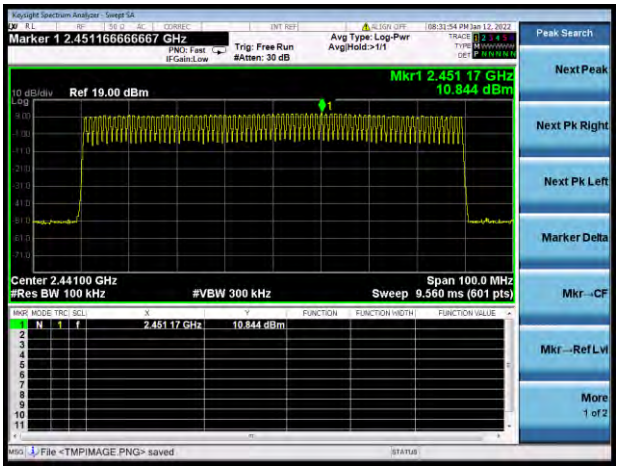


8-DPSK HIGH CHANNEL, SPURIOUS 30 MHz ~ 3 GHz



8-DPSK HIGH CHANNEL, SPURIOUS 3 GHz ~ 25 GHz

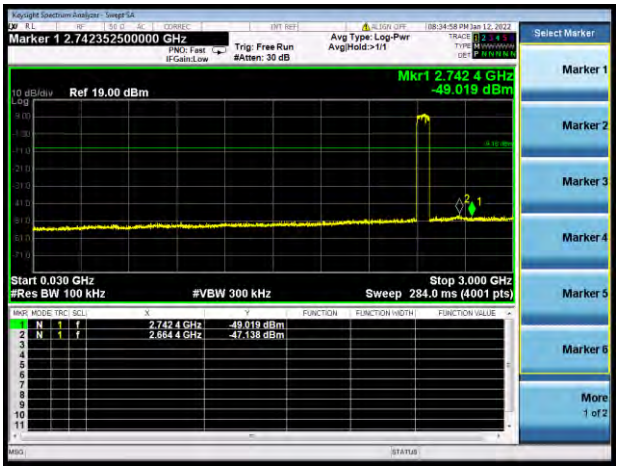
GFSK HOPPING, CARRIER LEVEL



GFSK HOPPING BAND EDGE (LOW)

GFSK HOPPING BAND EDGE (HIGH)

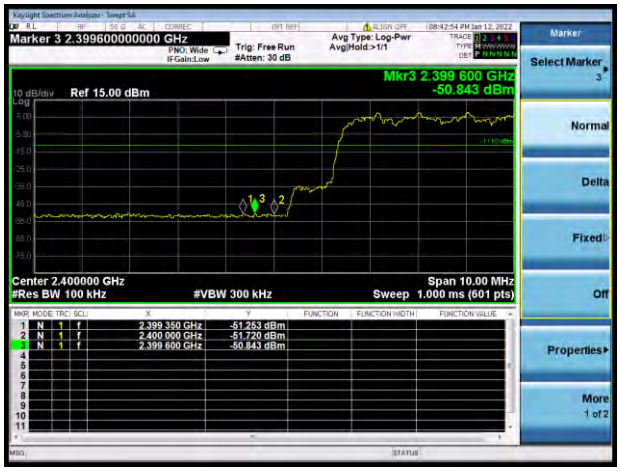
GFSK Hopping Mode, SPURIOUS 30 MHz ~ 3 GHz



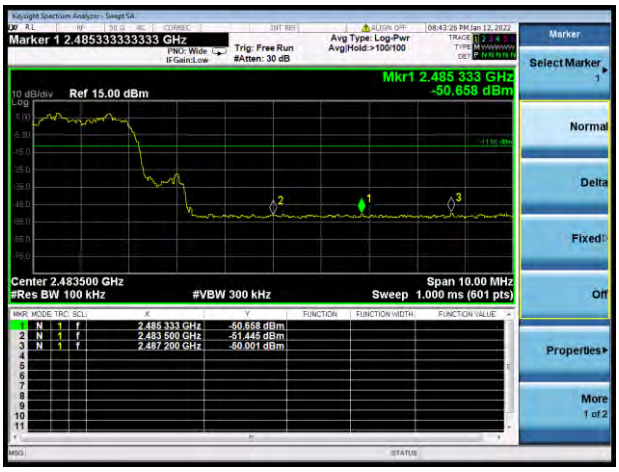
GFSK Hopping Mode, SPURIOUS 30 3GHz ~ 25 GHz

8-DPSK HOPPING, CARRIER LEVEL

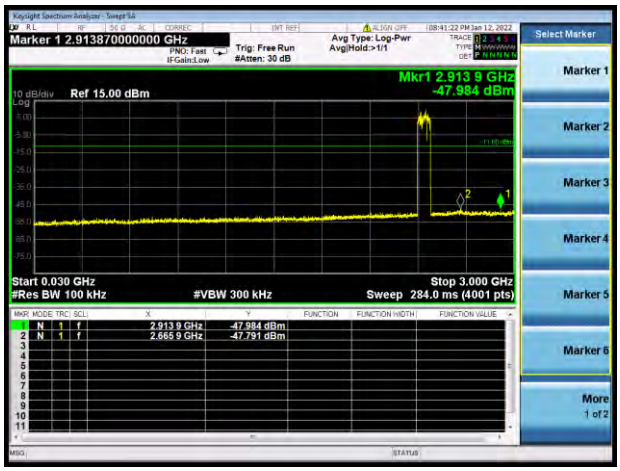
8-DPSK Hopping BAND EDGE (LOW)



8-DPSK Hopping BAND EDGE (HIGH)



8-DPSK Hopping Mode, SPURIOUS 30 MHz ~ 3 GHz



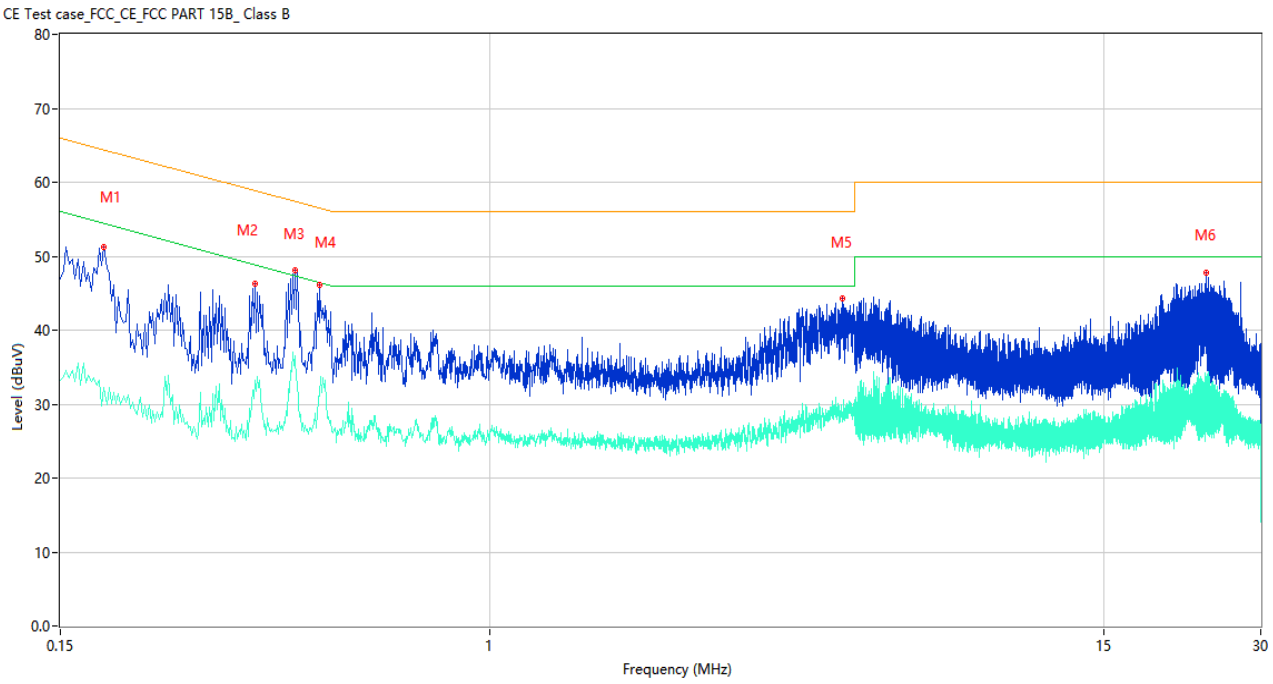
8-DPSK Hopping Mode, SPURIOUS 30 3GHz ~ 25 GHz

A.7 Conducted Emissions

Note [1]: The EUT is working in the Normal link mode. All modes have been tested and normal link mode is worst.
Note [2]: Devices subject to Part 15 must be tested for all available U.S. voltages and frequencies (such as a nominal 120 VAC, 60 Hz and 240 VAC, 50 Hz) for which the device is capable of operation. So, The configuration 120 VAC, 60 Hz and 240 VAC, 50 Hz were tested respectively, but only the worst configuration (120 VAC, 60 Hz) shown here.
Note [3]: Results (dBuV) = Original reading level of Spectrum Analyzer (dBuV) + Factor (dB)

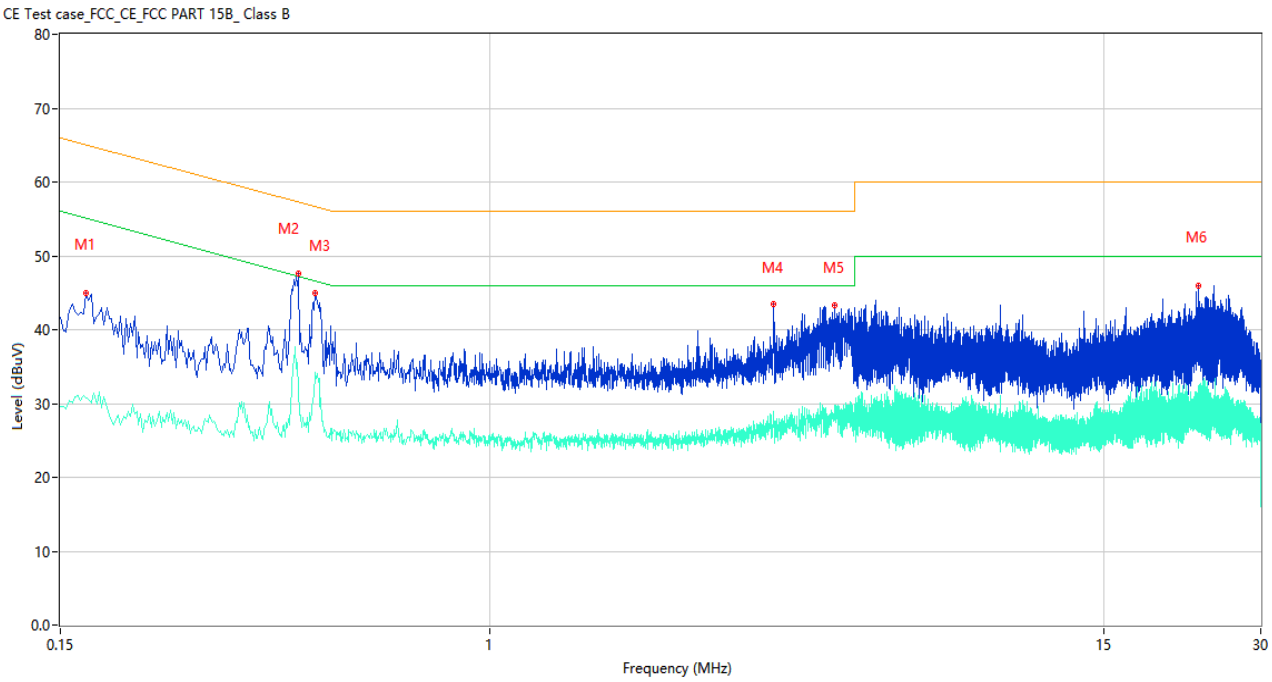
Test Data and Plots

PHASE L



No.	Frequency (MHz)	Results (dBuV)	Factor (dB)	Limit (dBuV)	Over Limit (dB)	Detector	Line	Verdict
1	0.182	51.20	10.97	64.39	-13.19	Peak	L	Pass
1**	0.182	32.29	10.97	54.39	-22.10	AV	L	Pass
2	0.354	46.28	10.89	58.87	-12.59	Peak	L	Pass
2**	0.354	33.15	10.89	48.87	-15.72	AV	L	Pass
3	0.422	48.13	10.91	57.41	-9.28	Peak	L	Pass
3**	0.422	36.55	10.91	47.41	-10.86	AV	L	Pass
4	0.470	46.14	10.92	56.51	-10.37	Peak	L	Pass
4**	0.470	31.88	10.92	46.51	-14.63	AV	L	Pass
5	4.736	44.38	10.69	56.00	-11.62	Peak	L	Pass
5**	4.736	28.24	10.69	46.00	-17.76	AV	L	Pass
6	23.604	47.71	10.61	60.00	-12.29	Peak	L	Pass
6**	23.604	33.28	10.61	50.00	-16.72	AV	L	Pass

PHASE N



No.	Frequency (MHz)	Results (dBuV)	Factor (dB)	Limit (dBuV)	Over Limit (dB)	Detector	Line	Verdict
1	0.166	42.11	10.98	65.16	-23.05	Peak	N	Pass
1**	0.166	31.01	10.98	55.16	-24.15	AV	N	Pass
2	0.430	47.67	10.91	57.25	-9.58	Peak	N	Pass
2**	0.430	32.07	10.91	47.25	-15.18	AV	N	Pass
3	0.462	44.97	10.91	56.66	-11.69	Peak	N	Pass
3**	0.462	34.17	10.91	46.66	-12.49	AV	N	Pass
4	3.500	43.46	10.71	56.00	-12.54	Peak	N	Pass
4**	3.500	28.04	10.71	46.00	-17.96	AV	N	Pass
5	4.584	43.32	10.70	56.00	-12.68	Peak	N	Pass
5**	4.584	28.85	10.70	46.00	-17.15	AV	N	Pass
6	22.736	45.97	10.70	60.00	-14.03	Peak	N	Pass
6**	22.736	32.37	10.70	50.00	-17.63	AV	N	Pass

A.8 Radiated Spurious Emission

Test Data and Plots

Note [1]: The symbol of "--" in the table which means not application.

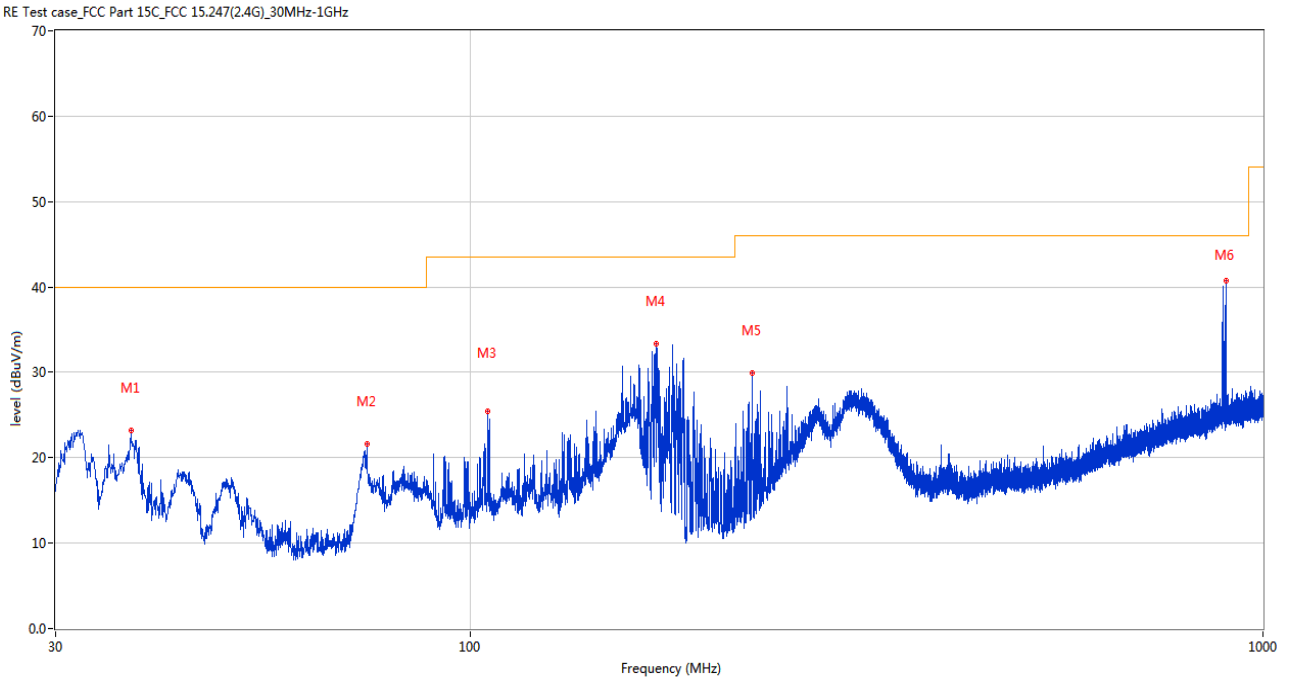
Note [2]: For the test data above 1 GHz, according the ANSI C63.10-2013, where limits are specified for both average and peak (or quasi-peak) detector functions, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement.

Note [3]: The EUT is working in the Normal link mode below 1 GHz. All modes have been tested and DH5-Hopping mode is the worst.

Note [4]: Results (dBuV/m) = Original reading level of Spectrum Analyzer (dBuV/m) + Factor (dB)

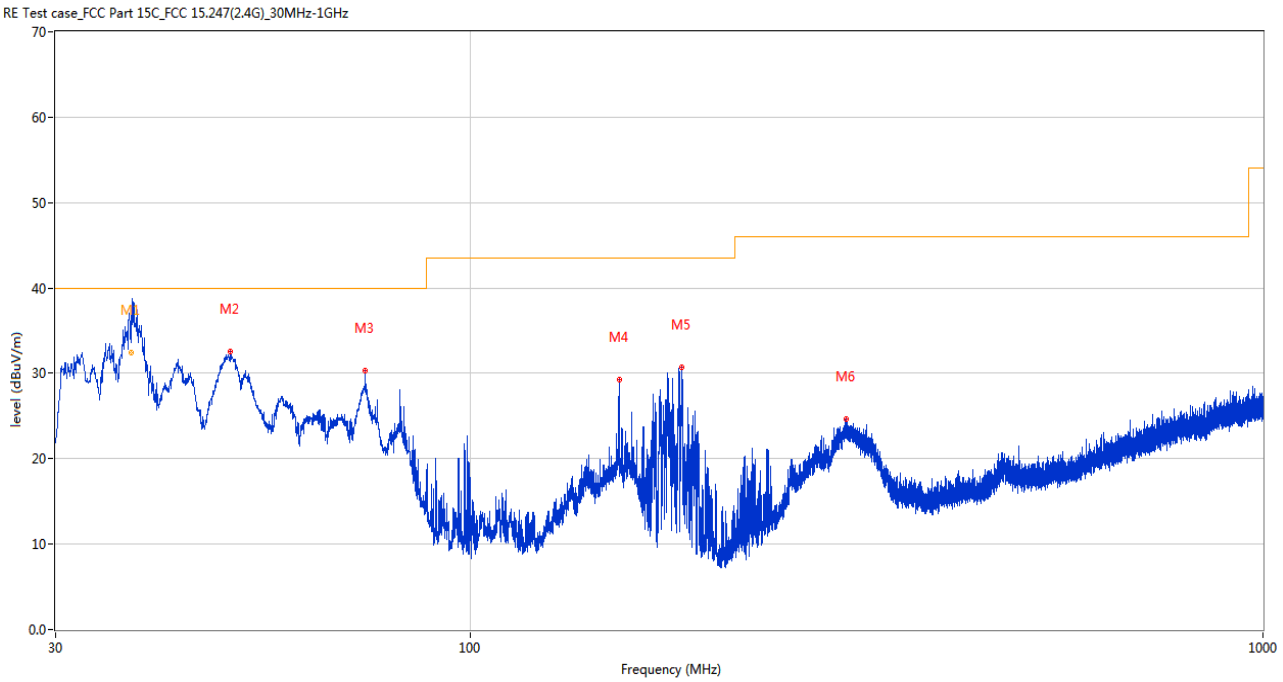
The low frequency, which started from 9 kHz to 30 MHz, was pre-scanned and the result which was 20 dB lower than the limit line per 15.31(o) was not reported.

30 MHz to 1 GHz, ANT H



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	37.372	23.15	-26.45	40.0	-16.85	Peak	1.00	200	Horizontal	Pass
2	74.184	21.63	-29.74	40.0	-18.37	Peak	1.00	200	Horizontal	Pass
3	105.272	25.47	-28.74	43.5	-18.03	Peak	90.00	200	Horizontal	Pass
4	171.766	33.32	-26.05	43.5	-10.18	Peak	105.00	200	Horizontal	Pass
5	226.667	29.97	-27.08	46.0	-16.03	Peak	268.00	200	Horizontal	Pass
6	898.393	40.70	-11.52	46.0	-5.30	Peak	318.00	200	Horizontal	Pass

30 MHz to 1 GHz, ANT V



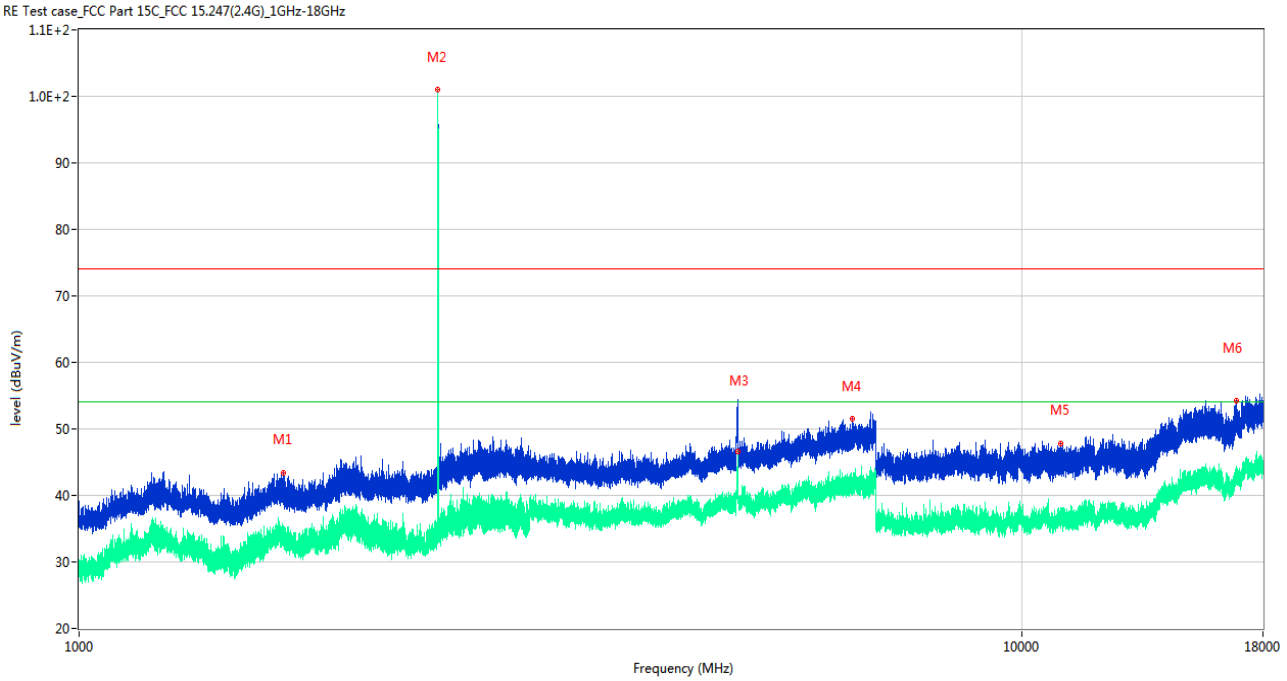
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	37.337	38.76	-26.44	40.0	-1.24	Peak	237.00	100	Vertical	N/A
1*	37.337	32.44	-26.44	40.0	-7.56	QP	237.00	100	Vertical	Pass
2	49.885	32.53	-26.65	40.0	-7.47	Peak	276.00	100	Vertical	Pass
3	73.747	30.30	-29.58	40.0	-9.70	Peak	1.00	200	Vertical	Pass
4	154.306	29.25	-24.87	43.5	-14.25	Peak	197.00	200	Vertical	Pass
5	184.861	30.73	-27.40	43.5	-12.77	Peak	245.00	100	Vertical	Pass
6	298.060	24.67	-23.99	46.0	-21.33	Peak	180.00	200	Vertical	Pass

Test Data and Plots (1 GHz ~ 10th Harmonic)

Note 1: The marked spikes near 2400 MHz with circle should be ignored because they are Fundamental signal.

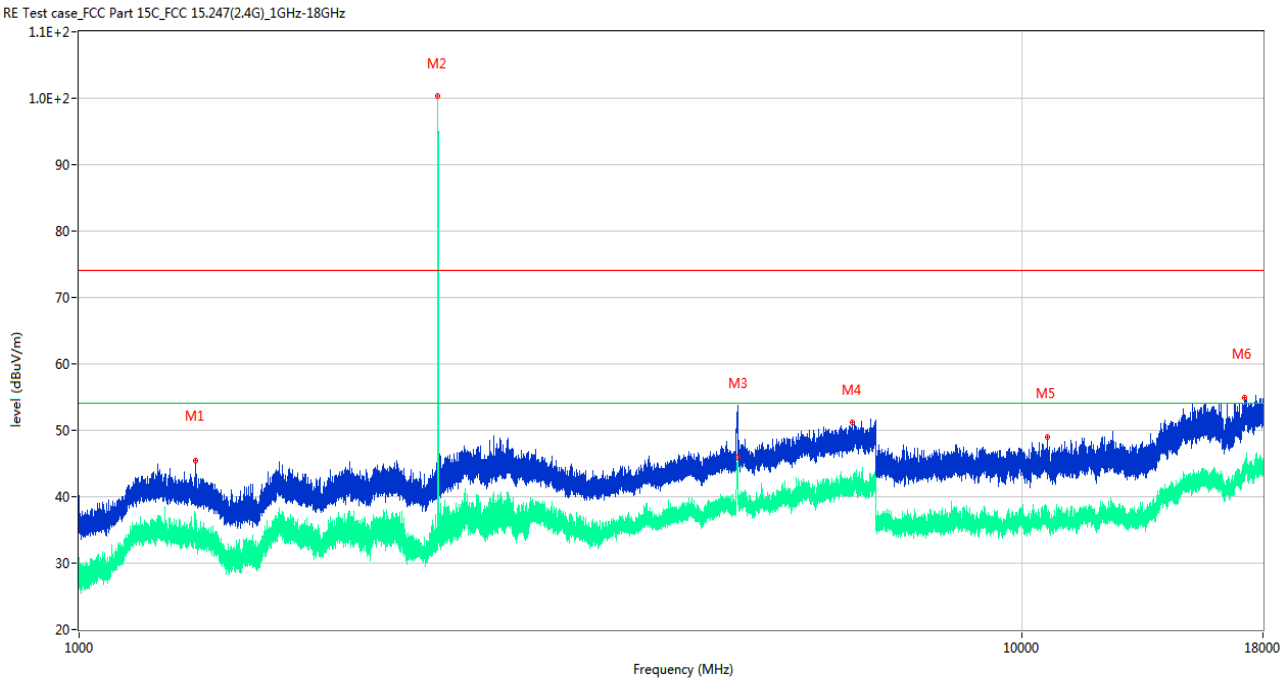
Note 2: The spurious from 18GHz-25GHz is noise only, do not show on the report.

GFSK LOW CHANNEL 1 GHz to 18 GHz, ANT H



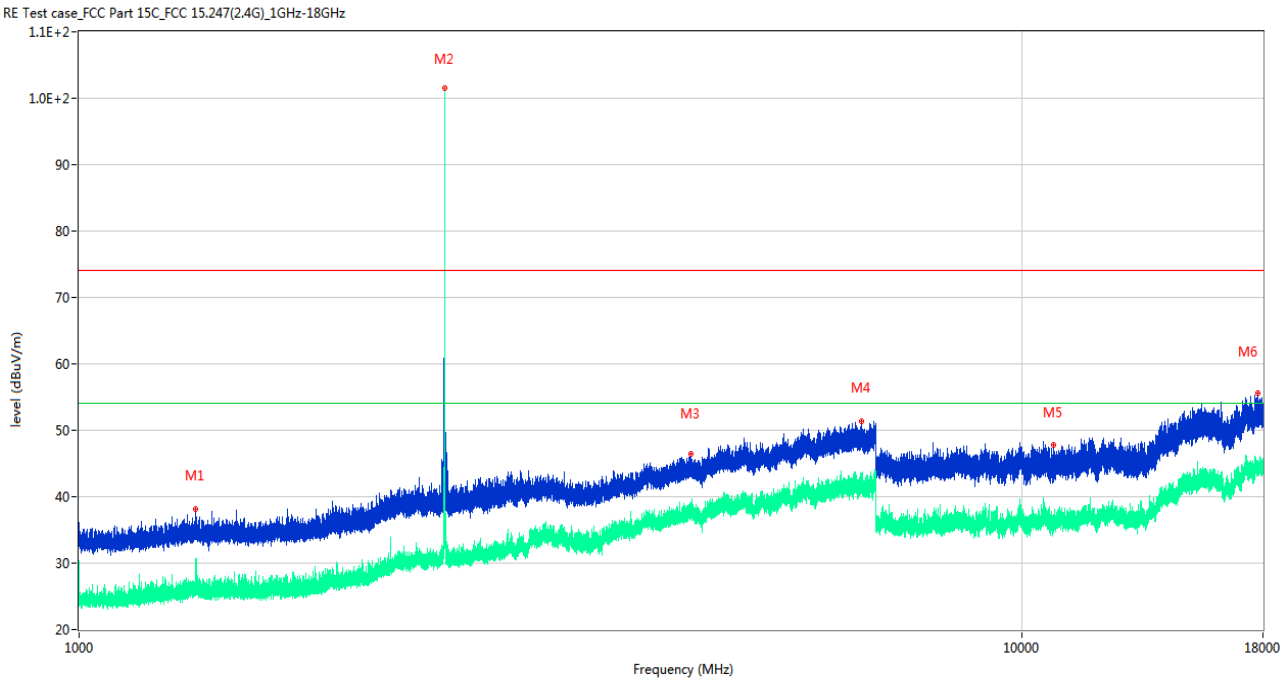
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1648.000	43.43	-15.18	74.0	-30.57	Peak	326.00	150	Horizontal	Pass
1**	1648.000	33.09	-15.18	54.0	-20.91	AV	326.00	150	Horizontal	Pass
2	2401.900	101.28	-10.74	74.0	27.28	Peak	314.00	150	Horizontal	N/A
2**	2401.900	100.44	-10.74	54.0	46.44	AV	314.00	150	Horizontal	N/A
3	4998.600	51.11	-0.85	74.0	-22.89	Peak	270.00	150	Horizontal	Pass
3**	4998.600	46.53	-0.85	54.0	-7.47	AV	270.00	150	Horizontal	Pass
4	6612.200	51.45	3.79	74.0	-22.55	Peak	270.00	150	Horizontal	Pass
4**	6612.200	41.50	3.79	54.0	-12.50	AV	270.00	150	Horizontal	Pass
5	10989.638	47.88	18.92	74.0	-26.12	Peak	72.00	150	Horizontal	Pass
5**	10989.638	36.05	18.92	54.0	-17.95	AV	72.00	150	Horizontal	Pass
6	16867.050	54.21	23.39	74.0	-19.79	Peak	268.00	150	Horizontal	Pass
6**	16867.050	43.54	23.39	54.0	-10.46	AV	268.00	150	Horizontal	Pass

GFSK LOW CHANNEL 1 GHz to 18 GHz, ANT V



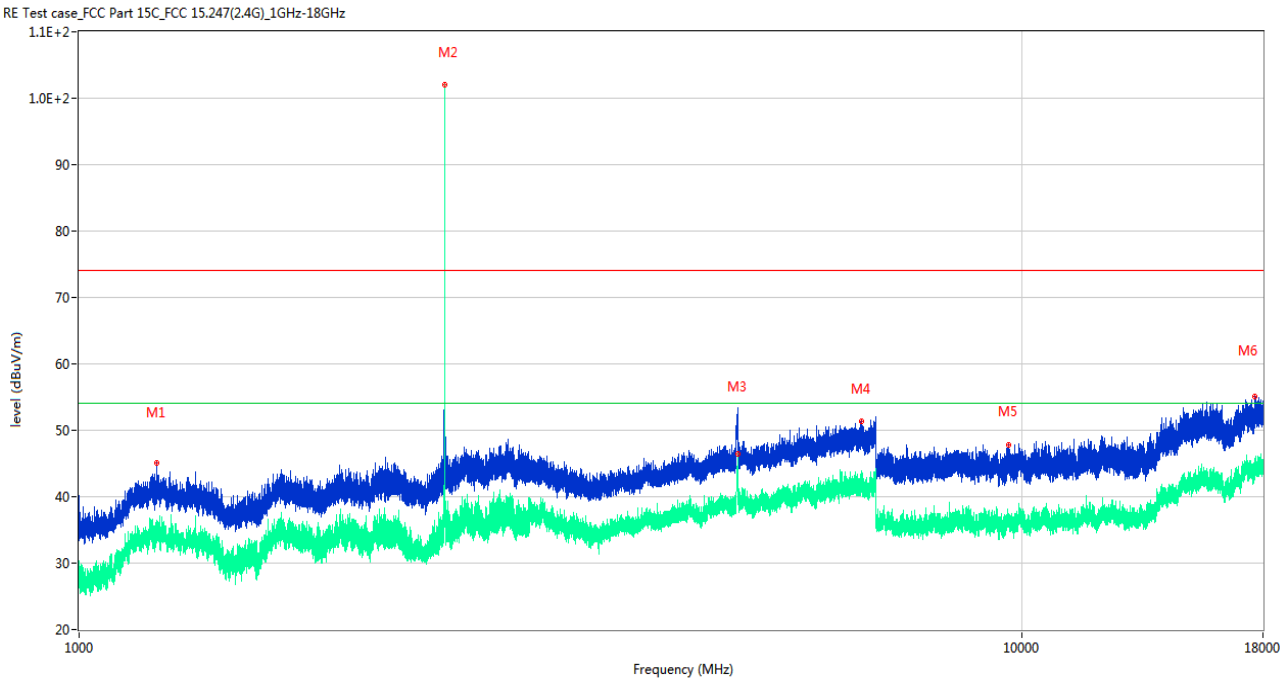
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1327.400	45.45	-14.72	74.0	-28.55	Peak	234.00	150	Vertical	Pass
1**	1327.400	37.47	-14.72	54.0	-16.53	AV	234.00	150	Vertical	Pass
2	2402.100	100.61	-10.74	74.0	26.61	Peak	139.00	150	Vertical	N/A
2**	2402.100	100.07	-10.74	54.0	46.07	AV	139.00	150	Vertical	N/A
3	4992.400	52.44	-1.01	74.0	-21.56	Peak	360.00	150	Vertical	Pass
3**	4992.400	45.89	-1.01	54.0	-8.11	AV	360.00	150	Vertical	Pass
4	6601.600	51.18	3.21	74.0	-22.82	Peak	108.00	150	Vertical	Pass
4**	6601.600	41.48	3.21	54.0	-12.52	AV	108.00	150	Vertical	Pass
5	10624.224	48.93	18.42	74.0	-25.07	Peak	0.00	150	Vertical	Pass
5**	10624.224	37.06	18.42	54.0	-16.94	AV	0.00	150	Vertical	Pass
6	17219.588	54.98	23.94	74.0	-19.02	Peak	39.00	150	Vertical	Pass
6**	17219.588	44.14	23.94	54.0	-9.86	AV	39.00	150	Vertical	Pass

GFSK MIDDLE CHANNEL 1 GHz to 18 GHz, ANT H



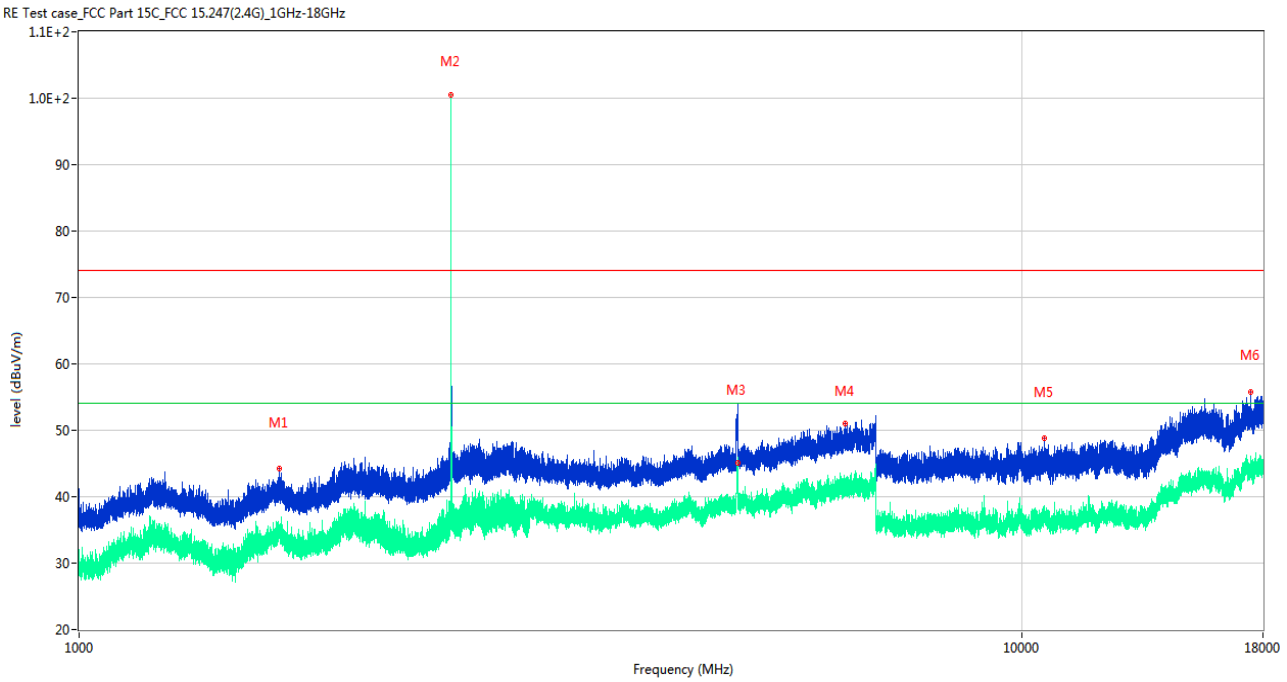
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1328.900	38.22	-14.62	74.0	-35.78	Peak	242.00	150	Horizontal	Pass
1**	1328.900	30.61	-14.62	54.0	-23.39	AV	242.00	150	Horizontal	Pass
2	2440.900	101.79	-10.52	74.0	27.79	Peak	322.00	150	Horizontal	N/A
2**	2440.900	101.06	-10.52	54.0	47.06	AV	322.00	150	Horizontal	N/A
3	4458.800	46.36	-2.59	74.0	-27.64	Peak	273.00	150	Horizontal	Pass
3**	4458.800	37.79	-2.59	54.0	-16.21	AV	273.00	150	Horizontal	Pass
4	6758.800	51.37	4.23	74.0	-22.63	Peak	162.00	150	Horizontal	Pass
4**	6758.800	41.69	4.23	54.0	-12.31	AV	162.00	150	Horizontal	Pass
5	10808.800	47.74	18.15	74.0	-26.26	Peak	316.00	150	Horizontal	Pass
5**	10808.800	35.67	18.15	54.0	-18.33	AV	316.00	150	Horizontal	Pass
6	17781.074	55.53	23.73	74.0	-18.47	Peak	73.00	150	Horizontal	Pass
6**	17781.074	43.31	23.73	54.0	-10.69	AV	73.00	150	Horizontal	Pass

GFSK MIDDLE CHANNEL 1 GHz to 18 GHz, ANT V



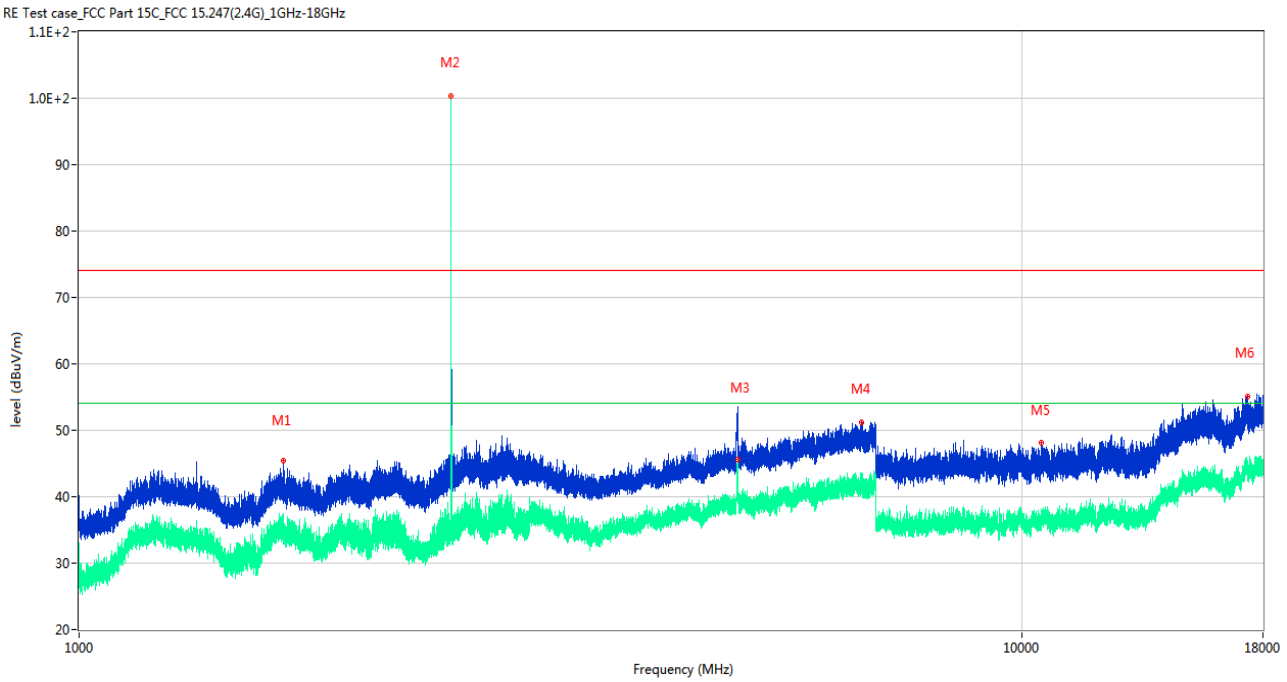
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1209.600	45.14	-14.91	74.0	-28.86	Peak	54.00	150	Vertical	Pass
1**	1209.600	36.24	-14.91	54.0	-17.76	AV	54.00	150	Vertical	Pass
2	2441.000	102.32	-10.52	74.0	28.32	Peak	126.00	150	Vertical	N/A
2**	2441.000	101.75	-10.52	54.0	47.75	AV	126.00	150	Vertical	N/A
3	4993.000	49.63	-1.03	74.0	-24.37	Peak	133.00	150	Vertical	Pass
3**	4993.000	46.42	-1.03	54.0	-7.58	AV	133.00	150	Vertical	Pass
4	6761.600	51.28	4.14	74.0	-22.72	Peak	360.00	150	Vertical	Pass
4**	6761.600	42.50	4.14	54.0	-11.50	AV	360.00	150	Vertical	Pass
5	9666.275	47.82	18.75	74.0	-26.18	Peak	0.00	150	Vertical	Pass
5**	9666.275	36.41	18.75	54.0	-17.59	AV	0.00	150	Vertical	Pass
6	17656.912	55.08	24.24	74.0	-18.92	Peak	44.00	150	Vertical	Pass
6**	17656.912	43.54	24.24	54.0	-10.46	AV	44.00	150	Vertical	Pass

GFSK HIGH CHANNEL 1 GHz to 18 GHz, ANT H



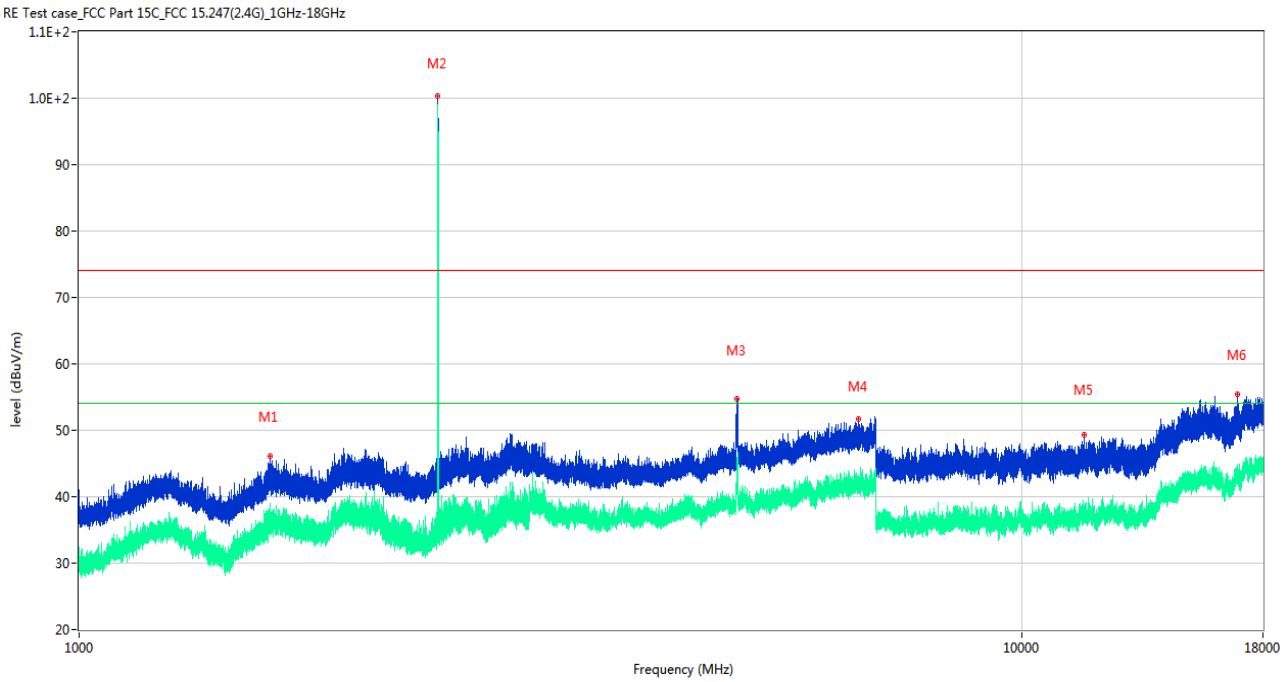
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1629.300	44.32	-14.72	74.0	-29.68	Peak	317.00	150	Horizontal	Pass
1**	1629.300	33.78	-14.72	54.0	-20.22	AV	317.00	150	Horizontal	Pass
2	2479.900	100.31	-10.36	74.0	26.31	Peak	317.00	150	Horizontal	N/A
2**	2479.900	99.38	-10.36	54.0	45.38	AV	317.00	150	Horizontal	N/A
3	4990.600	50.14	-1.05	74.0	-23.86	Peak	70.00	150	Horizontal	Pass
3**	4990.600	45.01	-1.05	54.0	-8.99	AV	70.00	150	Horizontal	Pass
4	6487.200	50.94	2.60	74.0	-23.06	Peak	61.00	150	Horizontal	Pass
4**	6487.200	41.65	2.60	54.0	-12.35	AV	61.00	150	Horizontal	Pass
5	10556.375	48.76	18.31	74.0	-25.24	Peak	209.00	150	Horizontal	Pass
5**	10556.375	36.95	18.31	54.0	-17.05	AV	209.00	150	Horizontal	Pass
6	17456.099	55.68	23.65	74.0	-18.32	Peak	139.00	150	Horizontal	Pass
6**	17456.099	43.41	23.65	54.0	-10.59	AV	139.00	150	Horizontal	Pass

GFSK HIGH CHANNEL 1 GHz to 18 GHz, ANT V



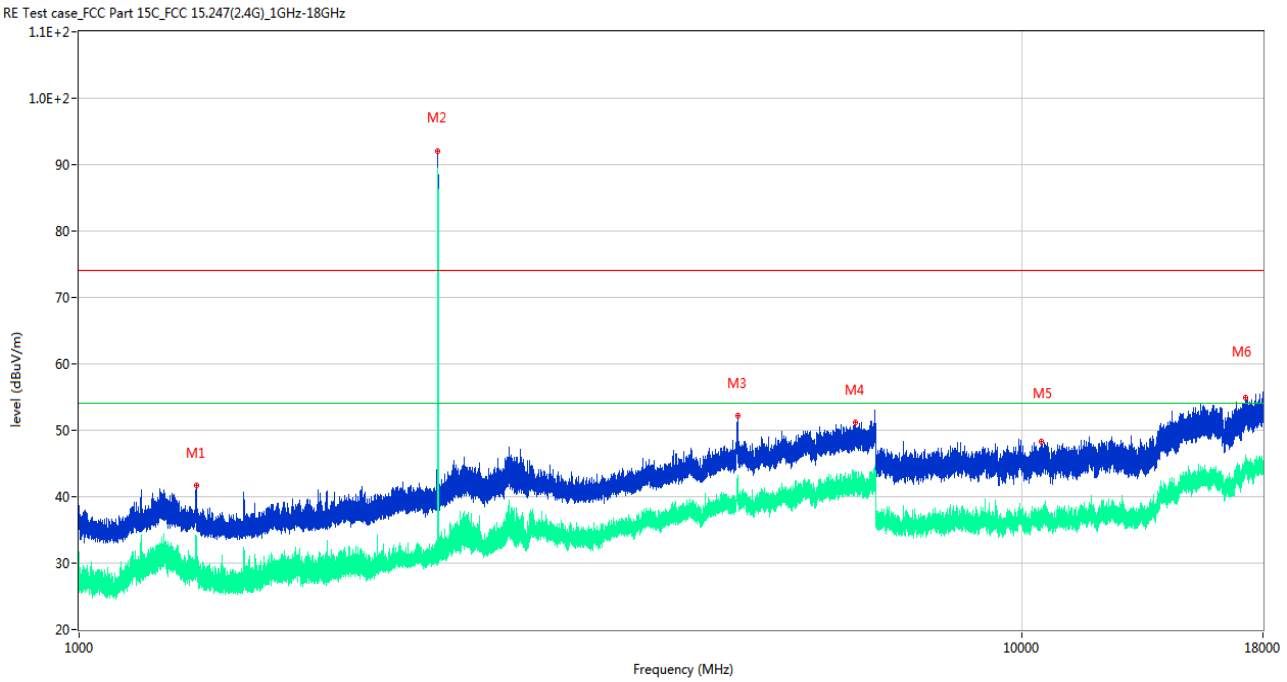
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1645.100	45.42	-15.08	74.0	-28.58	Peak	58.00	150	Vertical	Pass
1**	1645.100	34.45	-15.08	54.0	-19.55	AV	58.00	150	Vertical	Pass
2	2479.800	100.60	-10.36	74.0	26.60	Peak	131.00	150	Vertical	N/A
2**	2479.800	98.74	-10.36	54.0	44.74	AV	131.00	150	Vertical	N/A
3	4994.400	51.56	-1.04	74.0	-22.44	Peak	129.00	150	Vertical	Pass
3**	4994.400	45.64	-1.04	54.0	-8.36	AV	129.00	150	Vertical	Pass
4	6753.600	51.10	4.38	74.0	-22.90	Peak	149.00	150	Vertical	Pass
4**	6753.600	41.26	4.38	54.0	-12.74	AV	149.00	150	Vertical	Pass
5	10469.262	48.16	18.69	74.0	-25.84	Peak	0.00	150	Vertical	Pass
5**	10469.262	37.14	18.69	54.0	-16.86	AV	0.00	150	Vertical	Pass
6	17338.499	55.01	23.98	74.0	-18.99	Peak	26.00	150	Vertical	Pass
6**	17338.499	42.89	23.98	54.0	-11.11	AV	26.00	150	Vertical	Pass

8-DPSK LOW CHANNEL 1 GHz to 18 GHz, ANT H



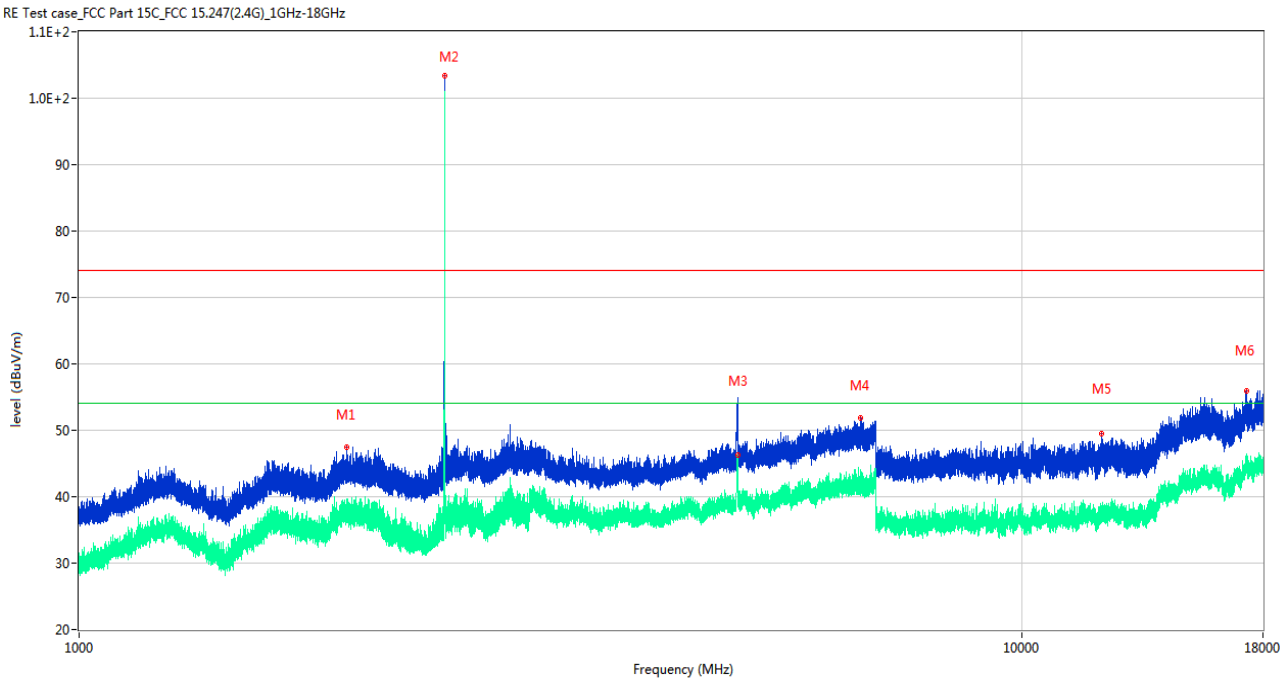
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1595.400	46.04	-15.09	74.0	-27.96	Peak	323.00	150	Horizontal	Pass
1**	1595.400	35.38	-15.09	54.0	-18.62	AV	323.00	150	Horizontal	Pass
2	2401.900	100.31	-10.74	74.0	26.31	Peak	74.00	150	Horizontal	N/A
2**	2401.900	97.06	-10.74	54.0	43.06	AV	74.00	150	Horizontal	N/A
3	4977.600	54.72	-1.34	74.0	-19.28	Peak	289.00	150	Horizontal	Pass
3**	4977.600	42.49	-1.34	54.0	-11.51	AV	289.00	150	Horizontal	Pass
4	6703.800	51.61	2.80	74.0	-22.39	Peak	118.00	150	Horizontal	Pass
4**	6703.800	41.30	2.80	54.0	-12.70	AV	118.00	150	Horizontal	Pass
5	11625.300	49.32	20.27	74.0	-24.68	Peak	252.00	150	Horizontal	Pass
5**	11625.300	38.33	20.27	54.0	-15.67	AV	252.00	150	Horizontal	Pass
6	16905.900	55.50	23.27	74.0	-18.50	Peak	264.00	150	Horizontal	Pass
6**	16905.900	43.10	23.27	54.0	-10.90	AV	264.00	150	Horizontal	Pass

8-DPSK LOW CHANNEL 1 GHz to 18 GHz, ANT V



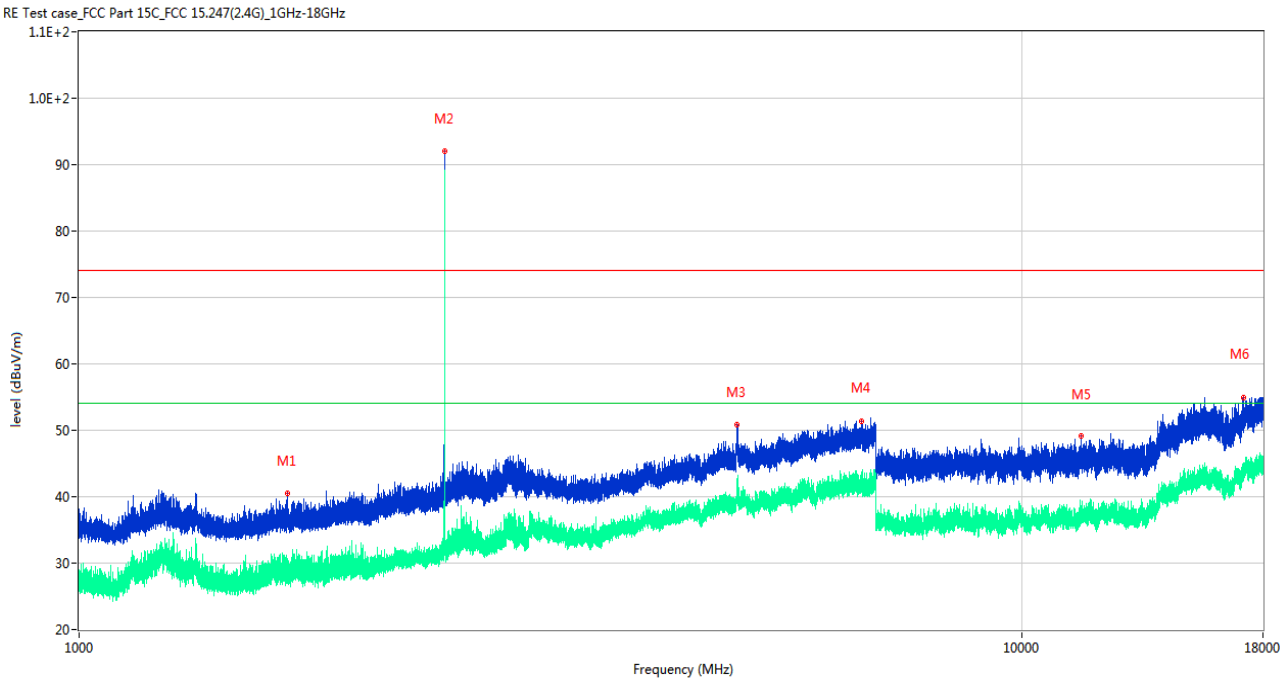
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1333.500	41.63	-14.70	74.0	-32.37	Peak	226.00	150	Vertical	Pass
1**	1333.500	30.00	-14.70	54.0	-24.00	AV	226.00	150	Vertical	Pass
2	2401.900	92.07	-10.74	74.0	18.07	Peak	233.00	150	Vertical	N/A
2**	2401.900	88.93	-10.74	54.0	34.93	AV	233.00	150	Vertical	N/A
3	4995.600	52.21	-0.99	74.0	-21.79	Peak	140.00	150	Vertical	Pass
3**	4995.600	41.51	-0.99	54.0	-12.49	AV	140.00	150	Vertical	Pass
4	6661.800	51.20	4.25	74.0	-22.80	Peak	160.00	150	Vertical	Pass
4**	6661.800	41.80	4.25	54.0	-12.20	AV	160.00	150	Vertical	Pass
5	10485.937	48.23	18.54	74.0	-25.77	Peak	188.00	150	Vertical	Pass
5**	10485.937	36.19	18.54	54.0	-17.81	AV	188.00	150	Vertical	Pass
6	17255.287	54.95	24.22	74.0	-19.05	Peak	169.00	150	Vertical	Pass
6**	17255.287	45.29	24.22	54.0	-8.71	AV	169.00	150	Vertical	Pass

8-DPSK MIDDLE CHANNEL 1 GHz to 18 GHz, ANT H



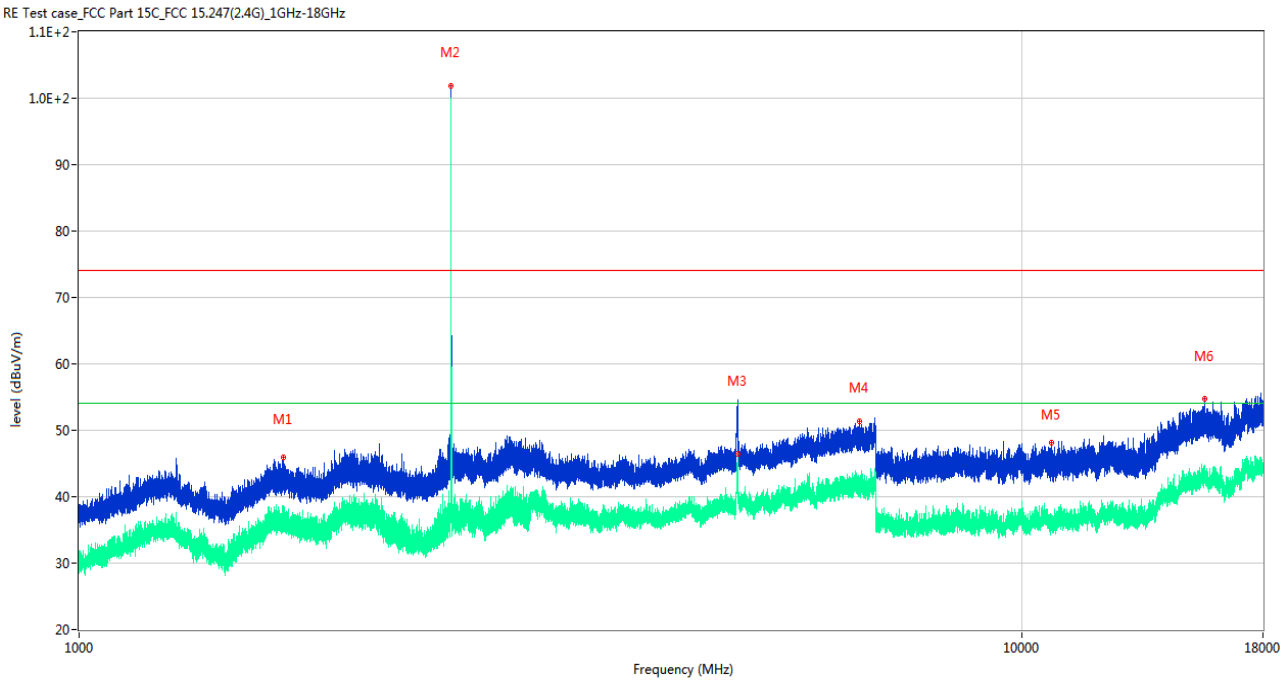
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1920.100	47.40	-13.81	74.0	-26.60	Peak	245.00	150	Horizontal	Pass
1**	1920.100	39.69	-13.81	54.0	-14.31	AV	245.00	150	Horizontal	Pass
2	2441.000	103.45	-10.52	74.0	29.45	Peak	67.00	150	Horizontal	N/A
2**	2441.000	100.35	-10.52	54.0	46.35	AV	67.00	150	Horizontal	N/A
3	4996.200	49.45	-0.96	74.0	-24.55	Peak	226.00	150	Horizontal	Pass
3**	4996.200	46.32	-0.96	54.0	-7.68	AV	226.00	150	Horizontal	Pass
4	6746.400	51.90	4.28	74.0	-22.10	Peak	111.00	150	Horizontal	Pass
4**	6746.400	41.39	4.28	54.0	-12.61	AV	111.00	150	Horizontal	Pass
5	12140.213	49.47	19.85	74.0	-24.53	Peak	240.00	150	Horizontal	Pass
5**	12140.213	37.44	19.85	54.0	-16.56	AV	240.00	150	Horizontal	Pass
6	17287.051	55.96	24.53	74.0	-18.04	Peak	66.00	150	Horizontal	Pass
6**	17287.051	44.45	24.53	54.0	-9.55	AV	66.00	150	Horizontal	Pass

8-DPSK MIDDLE CHANNEL 1 GHz to 18 GHz, ANT V



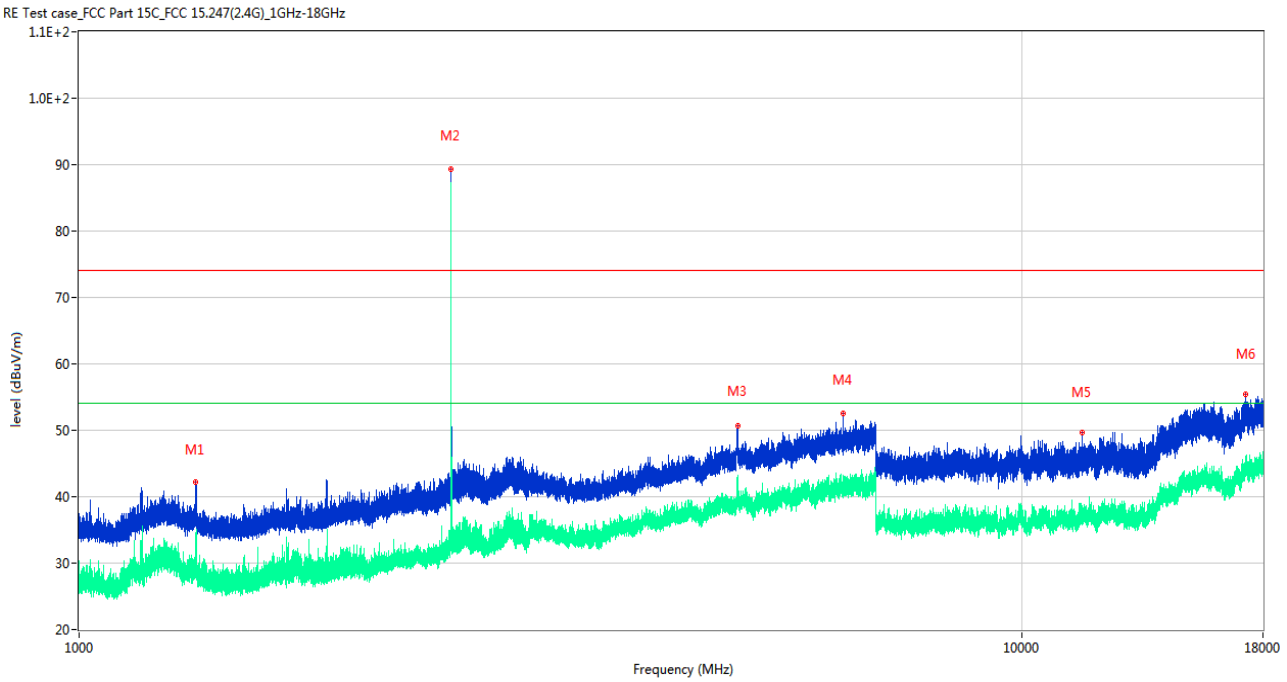
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1662.600	40.43	-15.16	74.0	-33.57	Peak	243.00	150	Vertical	Pass
1**	1662.600	28.15	-15.16	54.0	-25.85	AV	243.00	150	Vertical	Pass
2	2440.900	91.96	-10.52	74.0	17.96	Peak	236.00	150	Vertical	N/A
2**	2440.900	88.05	-10.52	54.0	34.05	AV	236.00	150	Vertical	N/A
3	4988.000	50.80	-1.18	74.0	-23.20	Peak	69.00	150	Vertical	Pass
3**	4988.000	40.88	-1.18	54.0	-13.12	AV	69.00	150	Vertical	Pass
4	6762.200	51.30	4.13	74.0	-22.70	Peak	238.00	150	Vertical	Pass
4**	6762.200	41.68	4.13	54.0	-12.32	AV	238.00	150	Vertical	Pass
5	11544.513	49.19	19.66	74.0	-24.81	Peak	0.00	150	Vertical	Pass
5**	11544.513	37.90	19.66	54.0	-16.10	AV	0.00	150	Vertical	Pass
6	17166.824	54.90	23.45	74.0	-19.10	Peak	9.00	150	Vertical	Pass
6**	17166.824	44.58	23.45	54.0	-9.42	AV	9.00	150	Vertical	Pass

8-DPSK HIGH CHANNEL 1 GHz to 18 GHz, ANT H



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1646.600	45.97	-15.21	74.0	-28.03	Peak	323.00	150	Horizontal	Pass
1**	1646.600	38.40	-15.21	54.0	-15.60	AV	323.00	150	Horizontal	Pass
2	2480.000	101.93	-10.35	74.0	27.93	Peak	302.00	150	Horizontal	N/A
2**	2480.000	100.01	-10.35	54.0	46.01	AV	302.00	150	Horizontal	N/A
3	4994.000	53.41	-1.06	74.0	-20.59	Peak	265.00	150	Horizontal	Pass
3**	4994.000	46.46	-1.06	54.0	-7.54	AV	265.00	150	Horizontal	Pass
4	6714.200	51.30	3.36	74.0	-22.70	Peak	6.00	150	Horizontal	Pass
4**	6714.200	42.94	3.36	54.0	-11.06	AV	6.00	150	Horizontal	Pass
5	10742.388	48.18	18.16	74.0	-25.82	Peak	338.00	150	Horizontal	Pass
5**	10742.388	36.89	18.16	54.0	-17.11	AV	338.00	150	Horizontal	Pass
6	15609.150	54.71	23.50	74.0	-19.29	Peak	37.00	150	Horizontal	Pass
6**	15609.150	41.88	23.50	54.0	-12.12	AV	37.00	150	Horizontal	Pass

8-DPSK HIGH CHANNEL 1 GHz to 18 GHz, ANT V



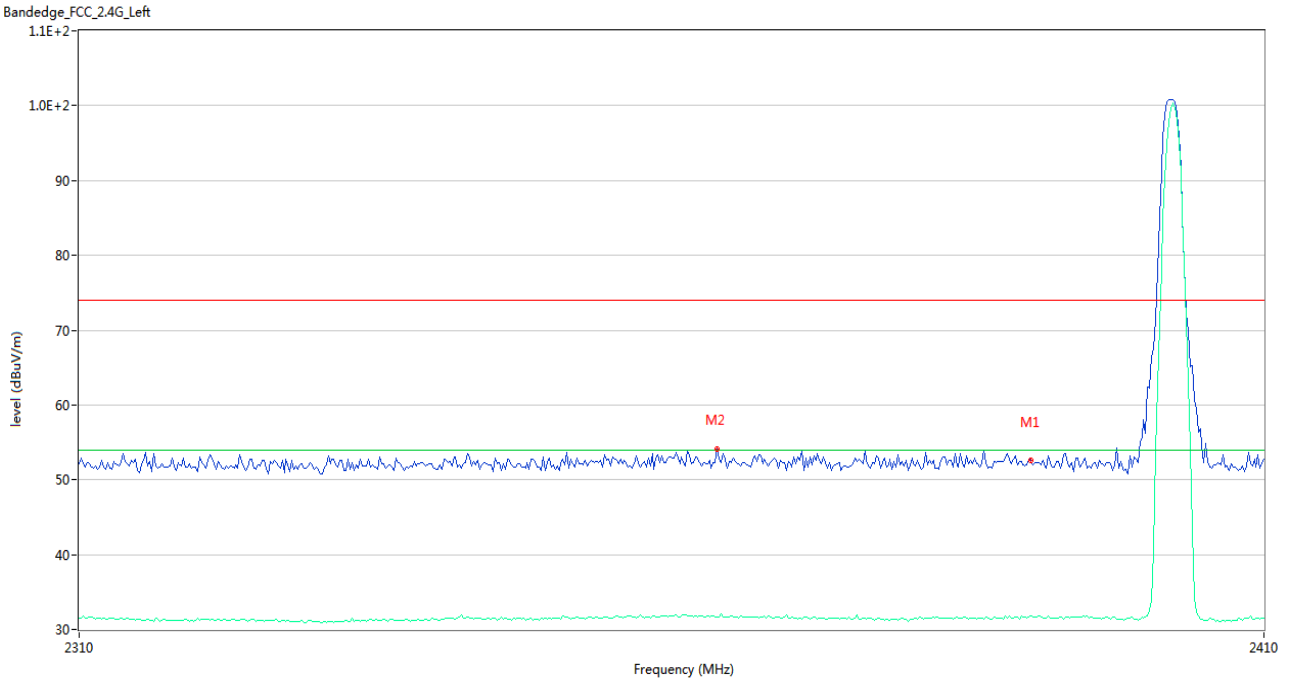
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1330.000	42.13	-14.55	74.0	-31.87	Peak	310.00	150	Vertical	Pass
1**	1330.000	33.80	-14.55	54.0	-20.20	AV	310.00	150	Vertical	Pass
2	2479.900	89.38	-10.36	74.0	15.38	Peak	194.00	150	Vertical	N/A
2**	2479.900	86.61	-10.36	54.0	32.61	AV	194.00	150	Vertical	N/A
3	4992.800	50.71	-1.03	74.0	-23.29	Peak	68.00	150	Vertical	Pass
3**	4992.800	40.75	-1.03	54.0	-13.25	AV	68.00	150	Vertical	Pass
4	6455.800	52.52	3.26	74.0	-21.48	Peak	177.00	150	Vertical	Pass
4**	6455.800	40.69	3.26	54.0	-13.31	AV	177.00	150	Vertical	Pass
5	11565.500	49.58	19.81	74.0	-24.42	Peak	75.00	150	Vertical	Pass
5**	11565.500	37.45	19.81	54.0	-16.55	AV	75.00	150	Vertical	Pass
6	17262.637	55.43	24.28	74.0	-18.57	Peak	194.00	150	Vertical	Pass
6**	17262.637	44.39	24.28	54.0	-9.61	AV	194.00	150	Vertical	Pass

A.9 Band Edge (Restricted-band band-edge)

Note [1]: The lowest and highest channels are tested to verify the band edge emissions. Please refer to the following the plots for emissions values.
Note [2]: The test data all are tested in the vertical and horizontal antenna which the trace is max hold. So these plots have shown the worst case.
Note [3]: According the ANSI C63.10-2013, where limits are specified for both average and peak (or quasi-peak) detector functions, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement.
Note [4]: The Level (dBuV/m) has been corrected by factor.

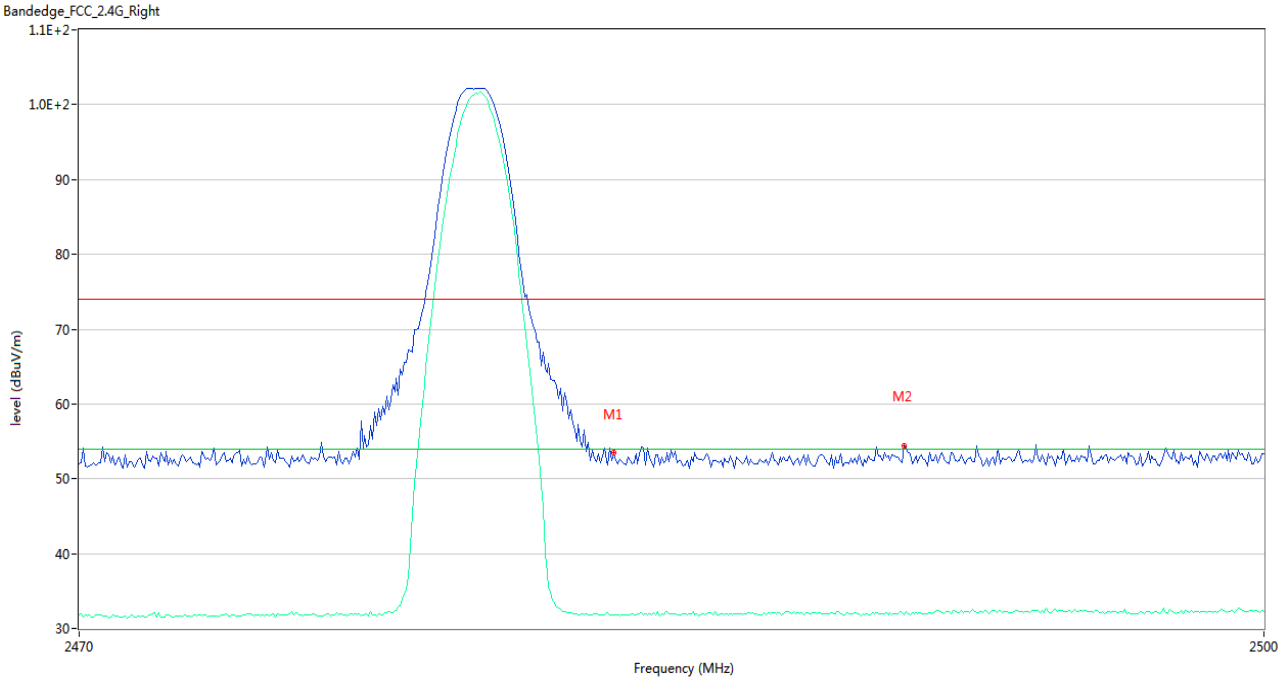
Test Data

GFSK LOW CHANNEL



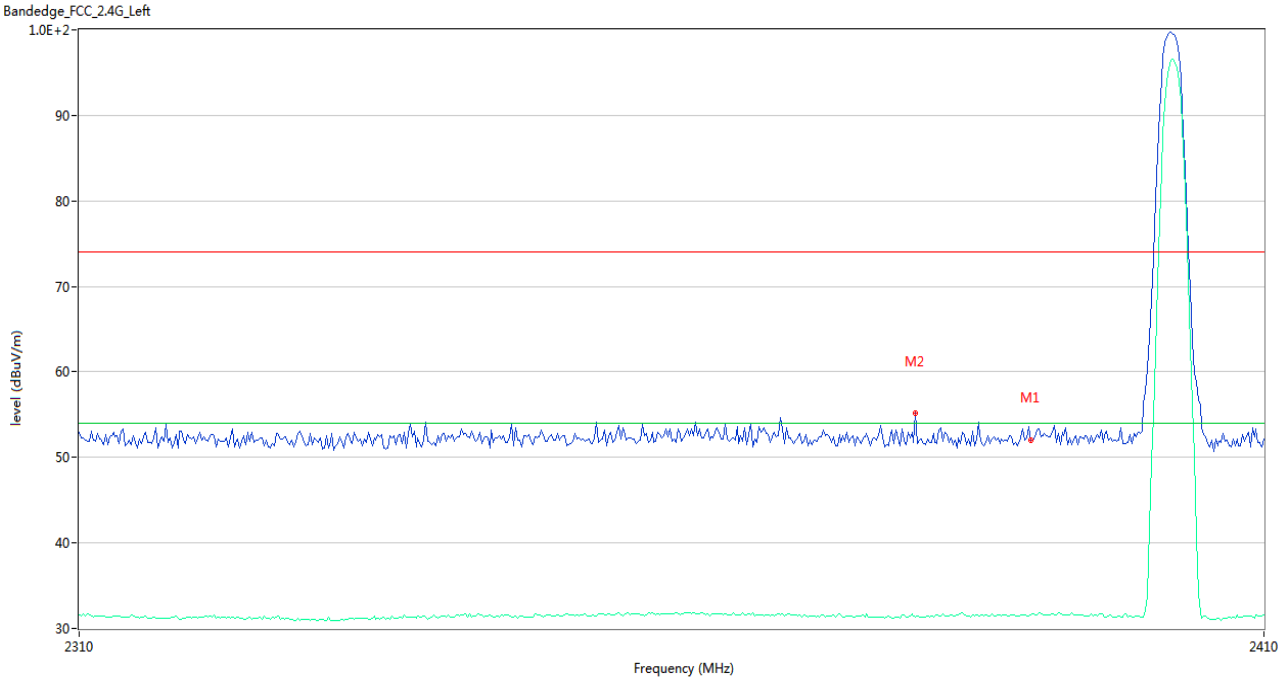
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2390.000	52.67	1.54	74.0	-21.33	Peak	225.00	150	Horizontal	Pass
1**	2390.000	31.87	1.54	54.0	-22.13	AV	225.00	150	Horizontal	Pass
2	2363.333	54.10	1.64	74.0	-19.90	Peak	98.00	150	Horizontal	Pass
2**	2363.333	31.73	1.64	54.0	-22.27	AV	98.00	150	Horizontal	Pass

GFSK HIGH CHANNEL,



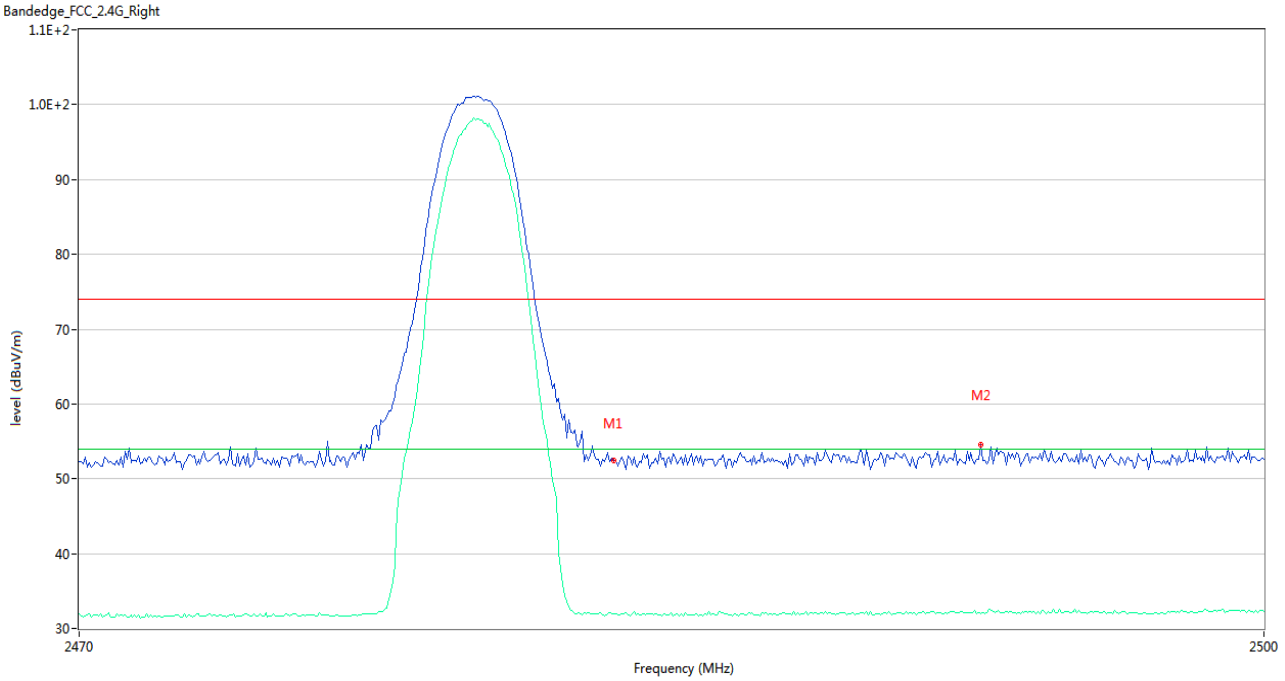
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2483.500	53.58	2.04	74.0	-20.42	Peak	124.00	150	Horizontal	Pass
1**	2483.500	31.83	2.04	54.0	-22.17	AV	124.00	150	Horizontal	Pass
2	2490.850	54.47	2.40	74.0	-19.53	Peak	157.00	150	Horizontal	Pass
2**	2490.850	31.86	2.40	54.0	-22.14	AV	157.00	150	Horizontal	Pass

8-DPSK LOW CHANNEL



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2390.000	52.03	1.54	74.0	-21.97	Peak	156.00	150	Horizontal	Pass
1**	2390.000	31.62	1.54	54.0	-22.38	AV	156.00	150	Horizontal	Pass
2	2380.167	55.14	1.49	74.0	-18.86	Peak	304.00	150	Horizontal	Pass
2**	2380.167	31.31	1.49	54.0	-22.69	AV	304.00	150	Horizontal	Pass

8-DPSK HIGH CHANNEL



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2483.500	52.38	2.04	74.0	-21.62	Peak	94.00	150	Horizontal	Pass
1**	2483.500	31.99	2.04	54.0	-22.01	AV	94.00	150	Horizontal	Pass
2	2492.800	54.54	2.55	74.0	-19.46	Peak	218.00	150	Horizontal	Pass
2**	2492.800	31.96	2.55	54.0	-22.04	AV	218.00	150	Horizontal	Pass

ANNEX B TEST SETUP PHOTOS

Please refer the document “BL-SZ21C10792-AR.PDF”.

--END OF REPORT--